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R denotes Reviews of Books. **P N** denotes Patent Notes. **T N** denotes Trade Notes and Novelties and Mechanical Department.

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THE BUILDING OF PERRET DYNAMOS AND MOTORS.

I.

FEW developments in the electrical domain of late years have been more rapid and more interesting than those which pertain to the electric motor industry. The practical utilization of electric power may be said to date from the International Electrical Exhibition of 1884, but it is only within the last two or three years that motor building has taken prominent place among the electric arts, opening up a field of activity and usefulness the limits of which no man can set. It is said by some observers that already the production of generators to furnish current for motors is larger than that of generators for lighting; and while this may not be true, it is evident that when the employment of lighting generators during daylight hours for power purposes is taken into account, the motor is even to-day well abreast of the lamp as a consumer of current. This state of affairs is in many respects matter for congratulation, and the double demand for current cannot but hasten the coming of the time when electric mains will ramify as universally and be availed of as freely as are water mains at this moment.

The popularity of electric power has, as readers of THE ELECTRICAL ENGINEER are well aware, called various types of motors into existence, the majority of which were of the high-speed type, a feature against which no small portion of the public raised objection on the very natural ground that such high speeds rendered it difficult to effect feasible and satisfactory combinations between the driving and the driven mechanism. One of the very first inventors and designers to give attention to the production of "slow speed" motors, was Mr. Frank A. Perret, and his ideas enlisted so much support that the Elektron Manufacturing Company was formed and a large factory started in Brooklyn, N. Y. Owing to the rapid growth of the business, larger quarters became necessary, and after the inspection

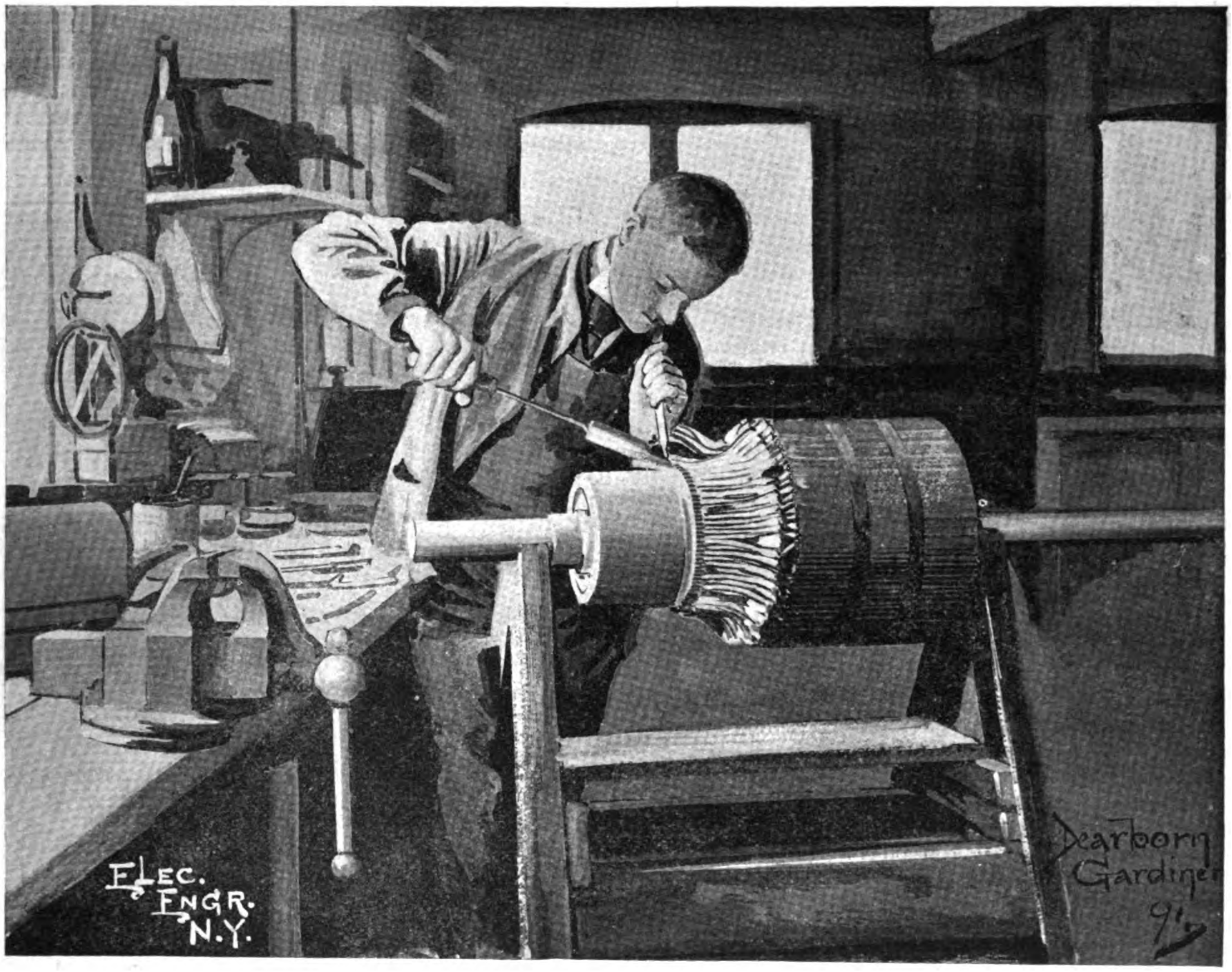


FIG 9.—CONNECTING ARMATURE COILS WITH COMMUTATOR IN A PERRET MOTOR.—(See page 6.)

of a number of properties, choice was made early last year of a fine manufacturing building at Springfield, Mass., whither a removal was made during the summer. The new factory is now in full swing, and the various processes and ideas there illustrated are so important, interesting and ingenious that no apology need be offered for making here an extended description of them, setting forth standard methods of motor manufacture in America.

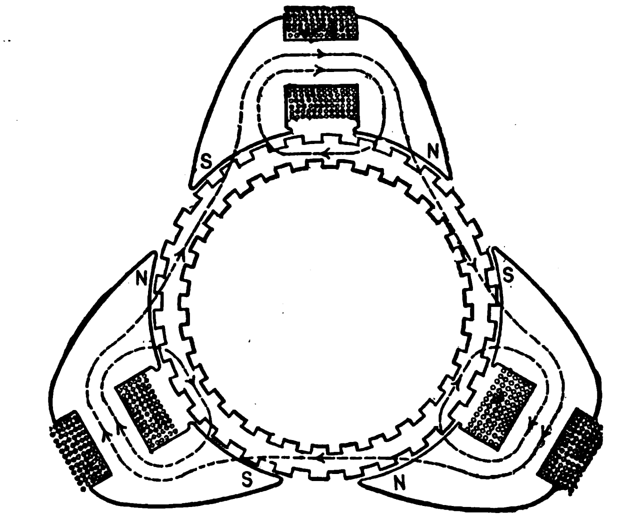


FIG. 1.—PERRET MULTIPOLAR FIELD.

II.

Before entering into a description of the method of manufacture adopted in the Perret motors, it may be well to touch briefly upon the reasoning which led Mr. Perret to design the machine as we find it. He had long recognized that the speeds at which the original types of bi-polar motors were operated were such as to lead to inconveniences and additional care in attendance at the motor, and necessitated as a rule the employment of counter-shafting, which always involved an additional expense whenever such a high-speed motor was installed. He had, therefore, started out at once with the problem of producing a slow-speed motor; that is to say, not to wind an armature to run slowly, but to design a machine for low speed which should have as high an efficiency as those of the high-speed bi-polar type. But how was this to be accomplished? Mr. Perret argued that in the ordinary two-pole machine the armature conductor crosses the magnetic circuit and cuts all the lines of force twice during a complete revolution, viz., where they enter the armature core at one pole and where they leave it at the other. Now, if we so dispose the magnetic circuit as to cause the lines of force to enter the armature core at one point, to leave it at another, to enter it again at a third point and to leave it at a fourth, it is obvious that the conductor will cut all the lines at four points in each revolution, and that it will, therefore, generate the same E. M. F. at one-half the original speed. If we increase the number of poles to six, we shall obtain the same effect at one-third the speed, etc., etc. This, then, is the principle of construction by which low speed is secured.

Fig. 1 is a diagram of the magnetic circuit of the Perret machine. As will be seen, there are but three magnets, each being isolated magnetically from the others excepting through the medium of the armature core, and completely isolated from the frame-work of the machine. They are formed of plates of soft sheet-iron, which are punched to the required shape and strung together on non-magnetic bolts by which they are secured to their supports. A single magnetizing coil forms two salient poles, and as each magnet is built of a large number of plates a uniform magnetic conductivity is secured. By this method of construction all danger of any inequality in the strength of the poles is avoided, and a magnetic circuit without joints and of the lowest possible resistance is secured. It is understood, of course, that in all cases the number of ampere turns on each magnet must be equal.

III.

The works, a view of which is given in Fig. 2, are situated on Wilbraham street, beside the New York & New England railroad, from which a side track is run in. The main building is of brick, 40 feet by 55 feet, and four stories high. It has a long three-story wing, 125 feet by 40 feet. In this wing the workrooms are located. A brick engine and boiler-house, 45 feet square, is situated north of the main building, with a 15-foot passageway between. The 16-inch leather belt, by which power is transmitted from the engine to the main shafting, passes above this driveway in a covered bridge.

The plan upon which the machinery and the works at Springfield, Fig. 2, have been laid out is such as to effect the greatest economy in time, both as to the manipulation of the raw material and the assembling of the finished parts. In the reception of the raw material the works are peculiarly fortunately situated by having the New York and New England railroad beside them, so that the raw material can practically be unloaded directly from the cars into the shop basement floor. This first floor is a little below the level of the street and constitutes the heavy machine-room where the heavy lathes, planers and drilling machines, are situated. In this department, among other things, the rough castings are finished off and a number of special tools are employed to insure accuracy in the pro-

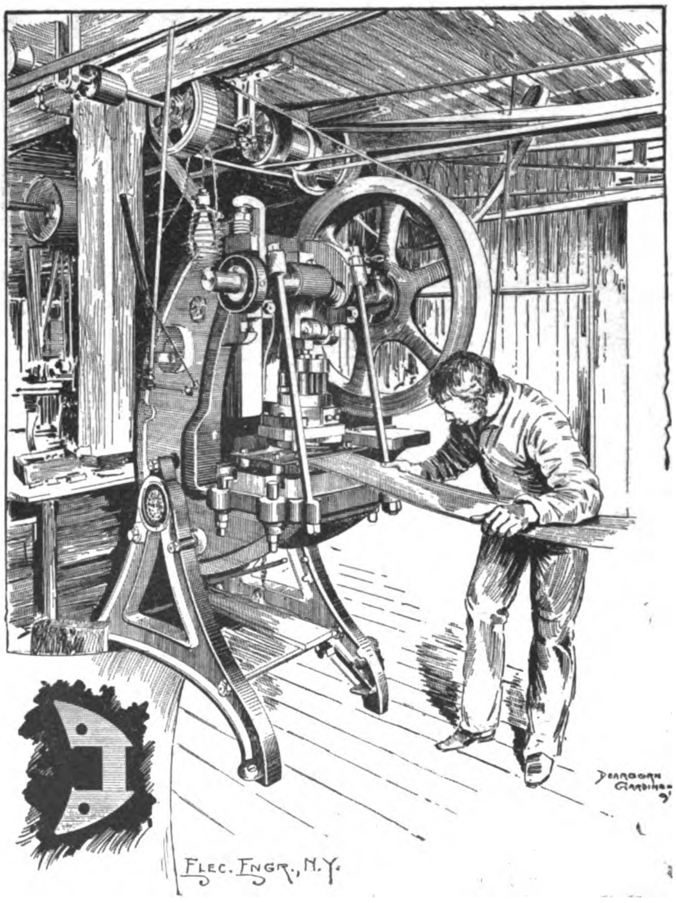


FIG. 3.—STAMPING OUT LAMINÆ FOR FIELDS.

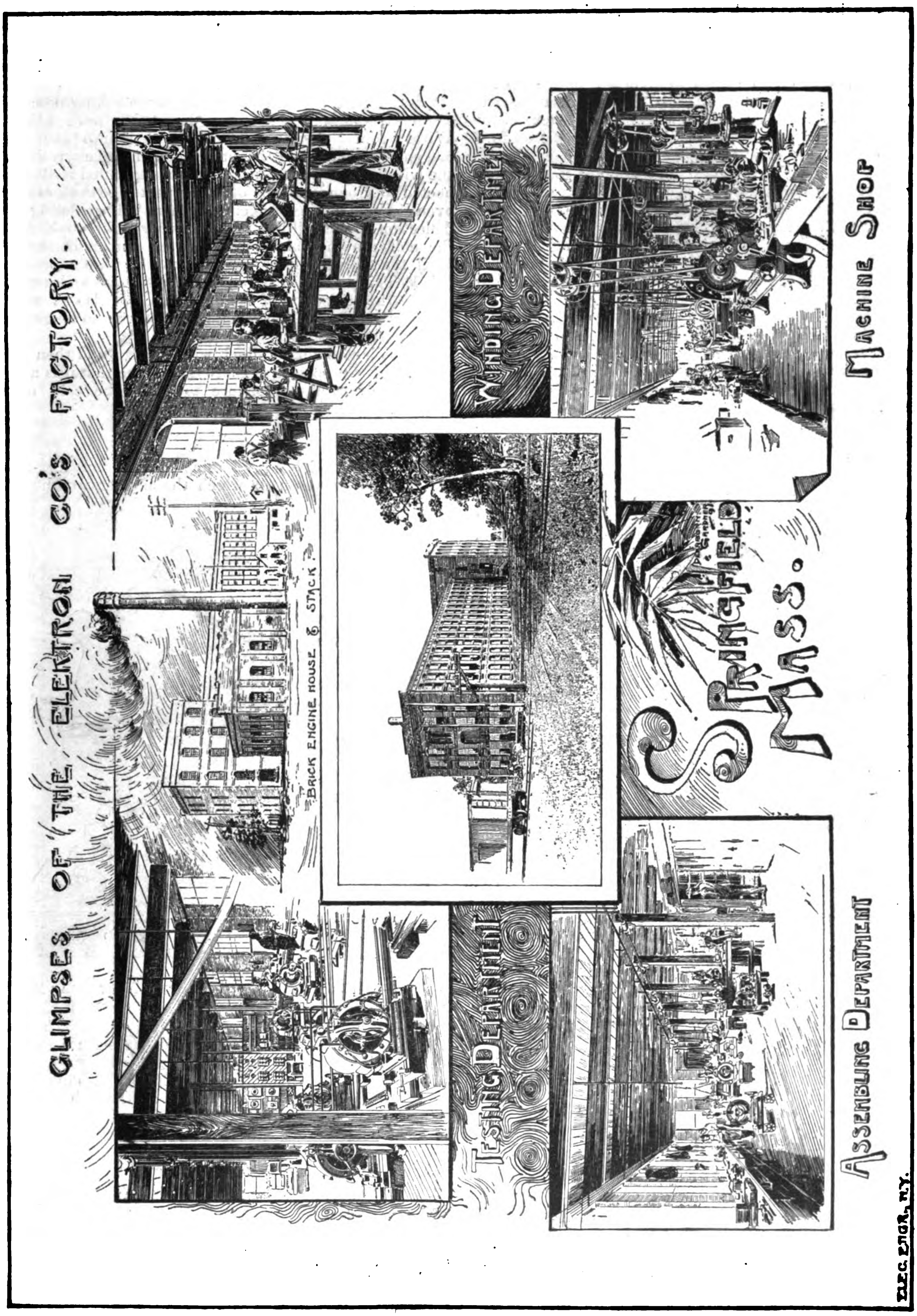


FIG. 2.—TESTING, WINDING, ASSEMBLING AND MACHINE DEPARTMENTS, ELEKTRON FACTORY, SPRINGFIELD, MASS.

ducts, as well as speed in their production. Notable among these is a special turntable "monitor" lathe, built by the Jones & Lamson Machine Works, of Springfield, which is able to take the heaviest cuts from stock and to screw thread shafts up to two inches in diameter in one operation. This machine alone performs practically automatically the work of a number of ordinary lathes attended by machinists, and on a size of work never heretofore attempted, with, of course, a large saving in time.

The engraving, Fig 2, shows the section of the machine shop devoted to the lathes and planers. On this floor also are situated the heavy presses for stamping out the sheets from which the armature and field magnets are built up. Our engraving, Fig. 3, shows one of these presses, which are able to stamp out the largest sized sheets required, and in the lower left-hand corner is shown the single stamping of the field magnet. The presses are placed close to the windows and the iron is dumped from the cars directly into a chute through the windows of the shop on to the floor. Here it is first cut up into suitable strips and then fed into the presses. Only the softest decarbonized steel is employed for this purpose, which has been rolled and pickled, and this quality of iron is used for both the armature and the field. Here we also find a well-regulated tool-room and a fireproof tool vault where the expensive dies and other standard jigs and gauges are stored, by which the work is constantly standardized in its progress and the tools kept to their correct size by comparison with the originals. The basement floor also contains the stock room where all raw material, such as castings, iron, brass, sheets, fibre and drop forgings, are kept in quantity and drawn from as the demand warrants.

Close beside this we find the room devoted to nickel plating and dipping, which the company has installed in order to avoid the delays frequently encountered in having this work done outside, and here also the polishing of the finished parts in brass is carried out. The freight elevator which passes up through the entire height of the building has its lowest landing on this floor, and is so arranged that trucks bringing in raw material back right up and deliver their goods directly upon the elevator platform, whence they are raised to the floor desired without further handling.

IV.

We will now ascend to the top floor of the building and trace the course of the work as it steadily proceeds towards the assembling-room below. This floor is devoted to the construction and winding of the field magnets and armatures.

The first operation in the construction of the field magnets is to punch the plates from the softest sheet iron that can be possibly obtained, which operation has just been described. The round holes through these plates are very carefully located and a number of the plates are then clamped together by bolts through the holes and with nuts on the same to form a field magnet, shown in Fig. 4. This constitutes one of the distinguishing features of the Perret machines, namely, that the magnets are built from plates of sheet iron instead of being made from a solid casting or forging.

The magnets thus constructed are then sent to the insulating-room where the magnet heads are applied and the magnet core and heads are thoroughly insulated by several thicknesses of canvas and tough paper prepared especially for this purpose and thoroughly shellacked.

The magnets thence pass to the winding-room where they are mounted between centres and revolved, the wire being wound on insulating and fire-proof spools, being guided by an attendant. This operation is well shown in the engraving, Fig. 4, which shows a coil almost completed.

After the magnets are wound, they are placed in a steam box and baked at a temperature of over 250 degrees until the shellac has been perfectly dried in place. Much inconvenience has been experienced in motor work, and, indeed, not a few troubles have developed, from the fact that the condition of the coils to be dried was not ascertained while the coil was in the oven. In order therefore to have an absolute means of ascertaining when the baking process is complete, the following arrangement has been adopted: Wires from the testing-room are led into the oven, one end grounded and the other touching one terminal of the wire coil. In the testing-room, one terminal is also connected to ground and the other connected to the coil in the oven. Upon closing the circuit there will evidently be a deflection if the coil has not been thoroughly baked, and the coils are thus always allowed to remain in the oven until the galvanometer shows that they are thoroughly dried. This method leaves no room for doubt and not only insures the perfection of the operation, but also saves time by allowing the coils to remain in the oven no longer than is absolutely necessary.

The coils are finally filled with shellac and then again dried. This process is so thoroughly done that it is almost impossible for any moisture to enter the coils of the magnet.

V.

While this work has been going on in the winding-room, the cast iron frames upon which the magnets are mounted have been finished in the machine department. These end frames carry the bearing in which the armature shaft revolves, and are plainly shown in Fig. 5.

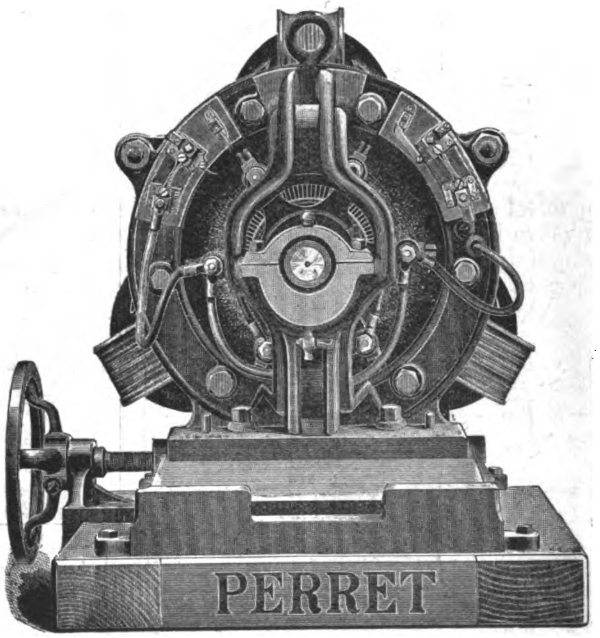


FIG. 5.—END VIEW OF PERRET LOW SPEED MULTIPOLAR MOTOR.

The same bolts which pass through the plates of the magnets binding them together, project through holes accurately located and drilled through the end frames and thus the field magnets are supported in perfect alignment with the armature.

There are three field magnets arranged at equal distances around the periphery of each armature. A bolt passes through the polar portions of each field, making two bolts to each magnet, six to each machine. The ends of these bolts are plainly seen projecting through the frame in the end view, Fig. 5.

The cast iron end frames are now bolted upon a cast-iron base which has been prepared to receive them. This base is so constructed that it slides in two cast iron ways or tracks which are bolted upon a wooden-base frame. The hand-wheel and screw are designed to force the machine in either direction on these tracks in order to loosen or tighten the belt which runs on the pulley of the machine.

The bearings of each machine are provided with a simple device by which they oil themselves. It consists of a brass ring of larger diameter than the shaft and which hangs upon the shaft inside the bearing and dips down into a chamber filled with oil. When the shaft revolves the ring revolves slowly and keeps the shaft constantly oiled. The only attention required is to change the oil every week or two.

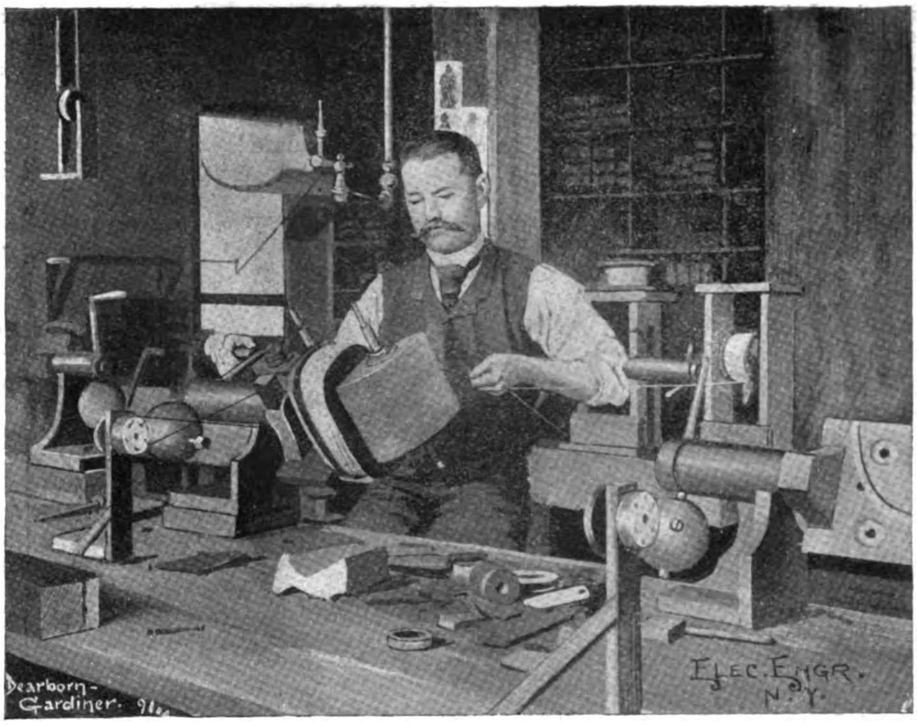
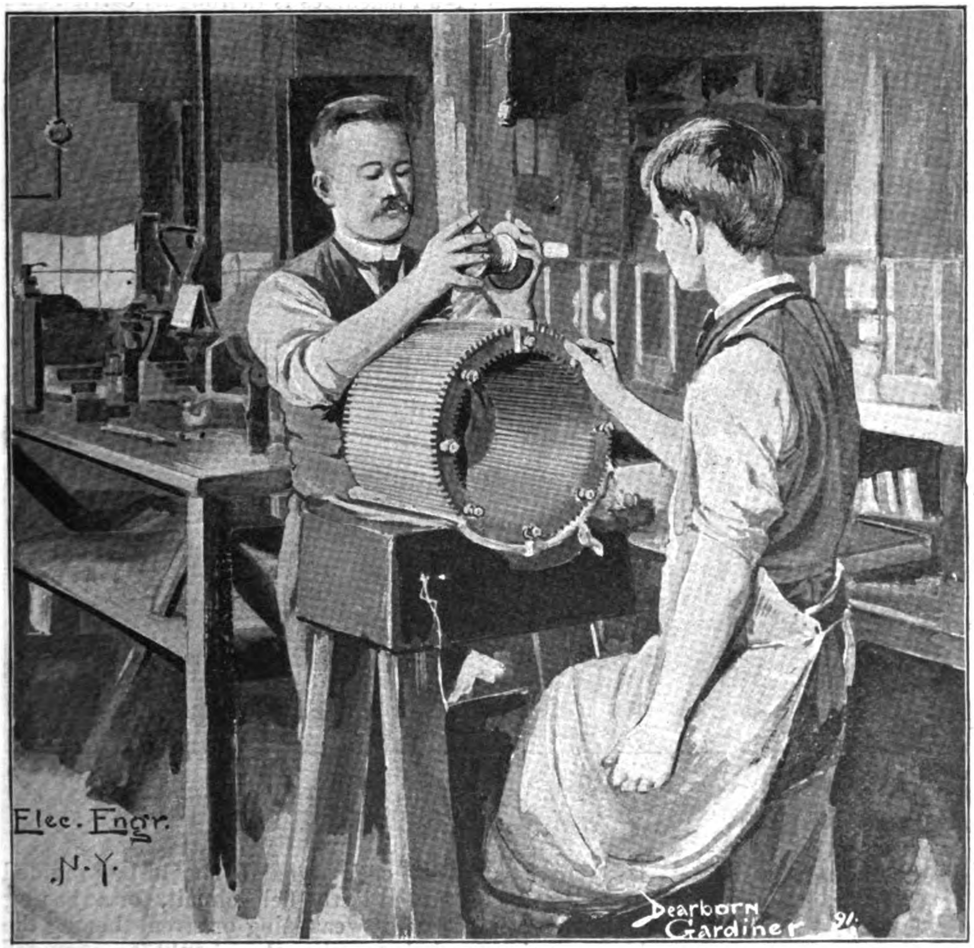

Dearborn-Gardiner. 91.
Elec. Engr. N.Y.

Fig. 4.—Winding a Perret Field Magnet.

VI.

The armature, that most important part of every dynamo-electric machine or motor, receives the most careful consideration in the Elektron Works. Its construction is commenced by cutting off a round bar of best quality steel to the proper length for the shaft and then carefully turning it in a lathe to the proper diameter; after this, key-ways or slots are cut in it by which the armature proper and the commutator may be mounted upon it. The plates are then punched out with which to build the armature core, being punched from the same quality of sheet iron as the field magnet plates. In order that the machines may be very efficient it is necessary that this iron should be of very high magnetic permeability.

The armature plates are ring-shaped with teeth on both the outside and inside of the ring. The appearance of the armature core after being built up from these plates by bolts passing through them is shown in Fig 6, and the channels formed in the periphery of the core by the teeth on the plates may also be clearly seen. The plates are held together and formed into a cylinder by screwing up nuts firmly on the ends of the eight insulated bolts which pass through them; and these same bolts serve also to attach the armature to the shaft by means of a disc or "spider" of gun metal at each end. Each spider is bored out to fit the shaft and has eight holes bored to fit the eight bolts.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Dearborn Gardiner 91.

Fig. 6.—Winding a Perret Armature.

The armature core is now ready to be insulated and wound. The insulation is very simply effected by means of what may be called a trough of insulating material which is slipped into each channel on the outside and also on the inside of the ring, after which a spool of magnet wire is taken and the winding is commenced. For each channel on the exterior of the ring there is a corresponding channel on the inside, and the depth and width of these channels are just right to contain the proper number of turns of wire.

The method of winding is clearly shown in the illustration, Fig. 6, one man drawing the wire through on the inside and the other pulling it over on the outside until the channel is filled. After filling one channel the end of the wire is passed onward to the next.

It is of the utmost importance in electrical machines that the wire shall be of sufficient size to carry the full current without heating and that it shall be so perfectly insulated that there shall be no contact between adjacent wires or with the iron core of the armature. Also that it shall be held so rigidly that it cannot be shifted out of place by any strain that may be thrown upon it. This is all facilitated by the plan of winding the wires in channels instead of winding on a smooth round periphery as is sometimes done. After the winding of the armature is completed it is dried, shellacked, and dried again, the same as in the case of the field magnet.

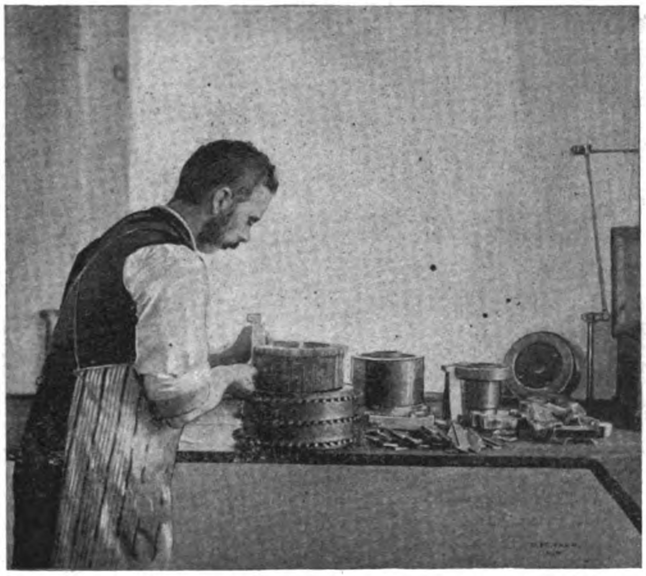


FIG. 7.—BUILDING UP A COMMUTATOR.

In order to mount the armature upon the shaft one of the spiders which we have previously described is bolted to each end of the armature ring by means of the same bolts that pass through the core and clamp the plates together, and the whole is then slipped upon and keyed to the shaft. The commutator is then slipped upon and keyed to the shaft.

VII.

The construction of the commutator, the tender spot in every continuous-current machine, is an operation requiring the greatest care. A single error, which might not appear on the surface, might be enough to cause serious trouble in the working of the machine. The method here adopted is illustrated in Fig. 7, showing the process of building up a commutator from the copper segments, a pile of which may be seen on the bench at the workman's right. Each of these segments must be set in its exact place inside the ring-shaped fixture, and it must be thoroughly insulated by a solid layer of best quality mica from every other section and also from the two end discs between which it is clamped. When all put together the commutator has the appearance shown in Fig. 8, which shows it mounted on a mandril undergoing its final turning in the lathe. The segments are all formed of the purest copper, and are provided with lugs which are slotted to receive the armature coils. Fig. 9 (page 1) shows the armature of a 20 h. p. motor and commutator for the same mounted on the shaft, which is supported upon a "horse," while the workman is engaged in soldering the armature coils to the commutator segments, an operation requiring considerable care and skill.

One of the most interesting features of the Perret machines lies in the fact that for all sizes of the machine between 4 and 20 horse power, but one diameter of armature, namely, 14 inches, is employed, the various sizes being built up by increasing the length of the armature; and in a like manner increasing the width of the pole-pieces by adding more sheets, according to the length of the armature. The great economy effected by this method of construction is so obvious as to need no further pointing out, and it will also be conceded that the designing of the teeth to meet the requirements of the space required by the various sizes of wire with which each machine is wound shows the highest skill in the design of the machine.

VIII.

We now descend to the floor below, where we find the assembling department. Here the heavy parts of the machine are brought up from below, and the magnets and armatures brought down from the floor above, where they are assembled, the parts being fitted together and bolted into place. Upon these operations our engraving, Fig. 10, shows a workman engaged, fitting brasses to the bearings of the motor. After this fitting it only remains to place the armature in position, connect the wires and start up the machine.

The motor is now ready to be transferred to the testing department, which is also situated on this floor, and a view of which is shown in Fig. 2. This testing department still employs, as a generator, the first 15 h. p. multipolar Perret machine built, and its continuous active service is probably as good a proof as could be found of the general excellence, both in design and workmanship, of this machine. Here the testing of all machines is thoroughly carried out, not only electrically, but mechanically. For the latter purpose an Emerson power scale is employed and every machine is put through a continuous run of several hours at more than its rated capacity before it is allowed to go out of the works.

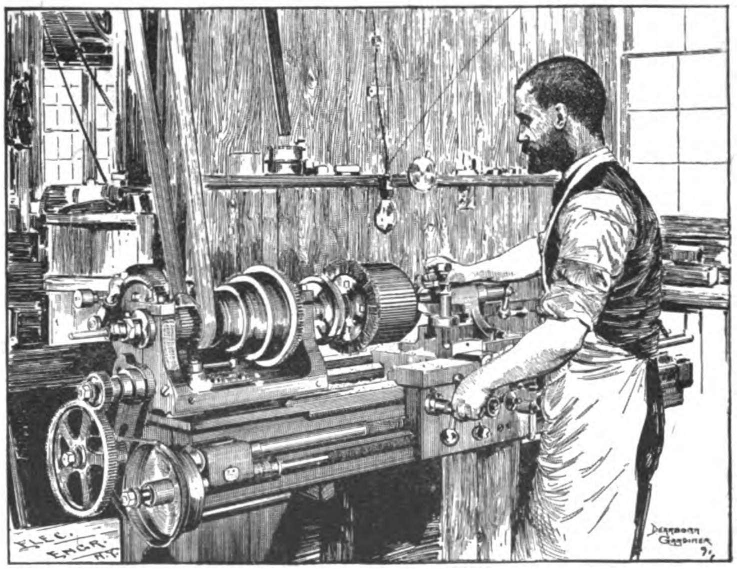


FIG. 8.—FINISHING COMMUTATOR IN LATHE.

IX.

It is necessary that each dynamo should be provided with a rheostat connected in the field circuit, for adjusting the electromotive force by weakening or strengthening the field magnetism, and that each motor should be provided with a rheostat or starting box in the armature circuit to prevent an excessive rush of current on starting up the machine. The construction of these rheostats has been the subject of special study in order to provide an apparatus which should be absolutely incombustible. The necessity of this is evident when it is considered that machines are frequently placed in the care of ignorant persons, and rheostats intended to be placed in circuit for a few moments only, are left with the full current turned on for hours. As a result of this experience, the Elektron Co. make all their rheostats and starting boxes entirely of non-combustible material. The resistance coils are of German silver or galvanized iron wire, which are supported in the iron box by porcelain bushings, and the contact plates are of brass on a slate base. The engraving, Fig. 11, shows the method of conducting these rheostats, which have now become one of the standard products of the Elektron Co.

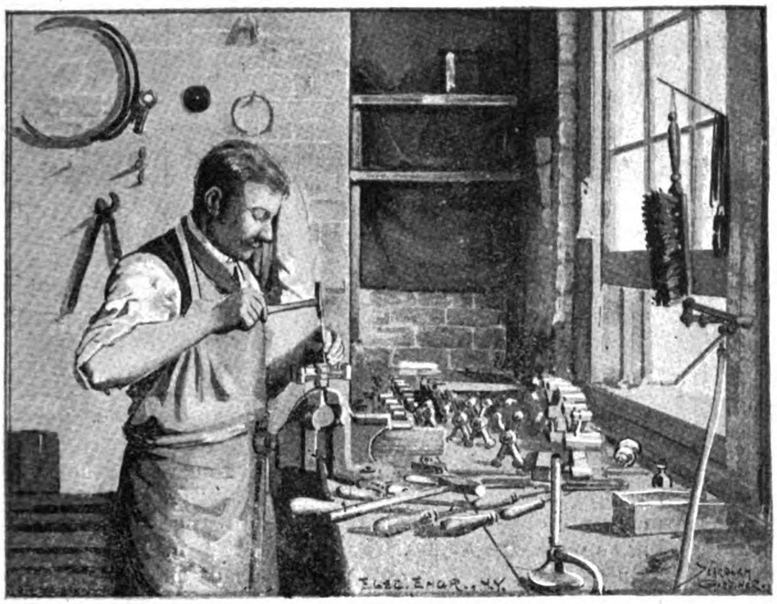

ELEC. ENGR., N.Y.

FIG. 10.—FITTING A MOTOR BEARING.

X.

A very important point in connection with all dynamo machinery is the brushes, and this has also engaged the special attention of Mr. Perret. Instead of using a solid carbon block a series of carbon pencils are employed, where the work to be effected is light and intermittent in its nature. For heavy and constant work, however, Mr. Perret has found the carbon block to be most efficient, when certain precautions are observed. Principal among these is the securing of a good connection between the carbon and the circuit wire. For this purpose the carbon brush is connected directly to the terminal wire by a short length of flexible cable, so that, having free movement under the influence of the springs, it forces itself against the commutator, the spring and the holder in which the carbon slides not being called upon to carry any of the current. The result is that the heating noted at the brushes where the latter take their current from the holder direct is practically overcome. Where the voltage is under 110 volts and heavy currents are to be carried, Mr. Perret still prefers the copper brush.

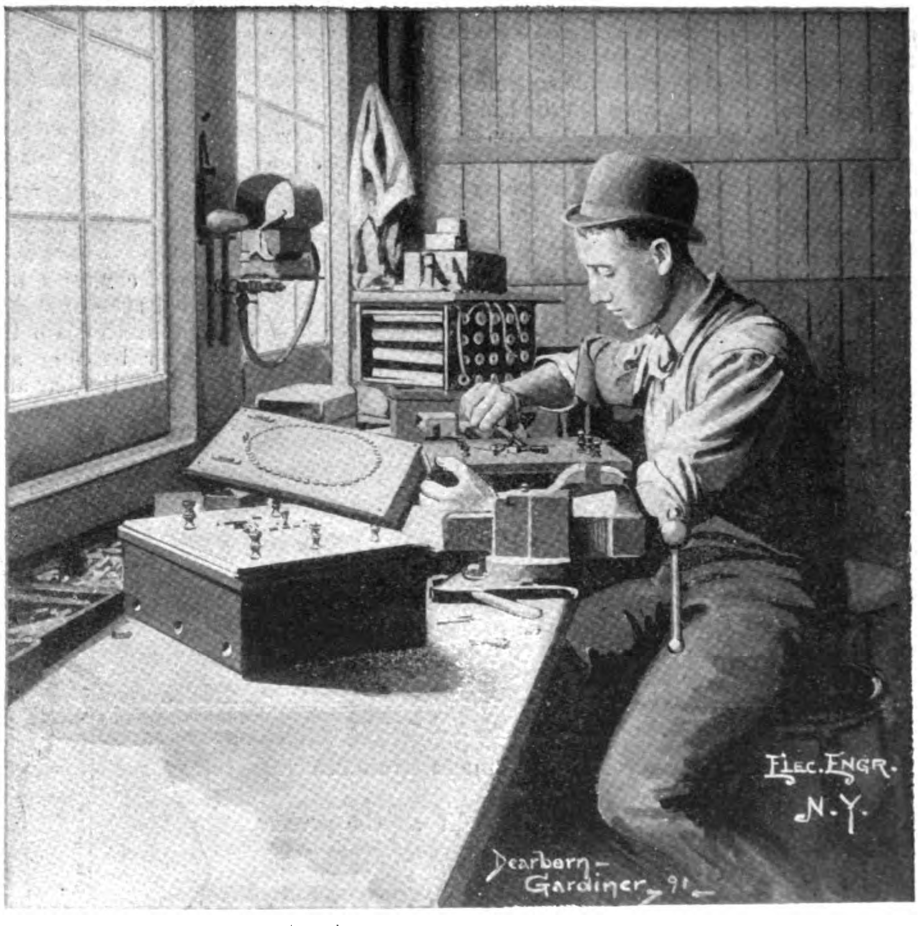


FIG. 11.—BUILDING AN ELEKTRON FIREPROOF RHEOSTAT.

XI.

The engravings, Figs. 5 and 12, show the standard Perret multipolar dynamos and motors, as at present constructed. In all essential points the construction is the same as that of the first machine which was brought out about two years. The only changes which have been found necessary have been in the minor details of the frame. In this respect the machines are quite remarkable and are a constant testimony to the genius of Mr. Perret as a designer.

The production of the company consists very largely of these multipolar machines and during the past year the demand for them has been rapidly increased, not only for use as motors but also as dynamos for isolated plants, for which purposes they possess unusual advantages by reason of their high efficiency, perfect regulation and the small attention required. In these machines the reduced speed is obtained without increase of weight or of space over the ordinary, and for this reason the dynamos are in great demand for places where economy of space is important, as on shipboard.

One of the most important attributes of any machine, whether used as a dynamo or as a motor, is its regulating qualities. For incandescent lighting the desirability of closest regulation is obvious, and on the other hand, an electric motor whose speed is not uniform at all loads does not fill the requirements for most purposes. Perhaps the best way of demonstrating the regulating qualities of the Perret machine was that embodied in a test shown to the writer at the works of the company during a recent visit. The machine in question was coupled direct to a steam engine, the plant, illustrated in Fig. 13, being intended as a marine electric lighting plant. At the writer's suggestion the machine was loaded to its full capacity and the main switch opened and closed successively. In neither case could a variation of more than a small fraction of a volt be detected upon a Weston voltmeter. This type of marine plant will shortly be installed in a number of yachts and steamships, and it is safe to assume that it will form an important branch of the business of the Elektron Company. Certainly every one noting such a test must be impressed with the perfection to which the regulation of dynamos and motors has been brought at the present time.

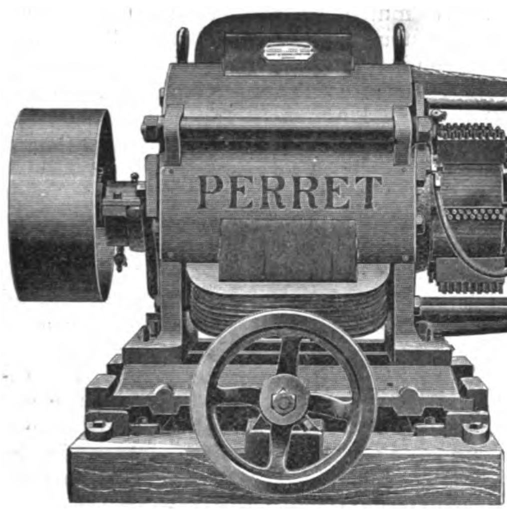


FIG. 12.—SIDE VIEW OF PERRET LOW-SPEED MULTIPOLAR MOTOR.

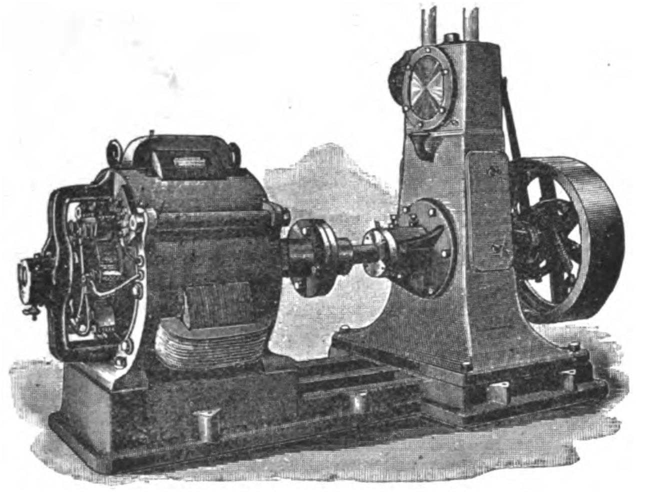


FIG. 13.—DIRECT CONNECTED PERRET SHIP LIGHTING PLANT.

XII.

There are many situations in which a machine developing from ¼ to 2 h. p. is required, and for this purpose the type illustrated in Fig. 14 has been designed and is regularly built at the Elektron Works. It is of the bi-polar type and, like the multipolar machines, has both its field and armature built up of soft laminated iron.

Not a little attention has been bestowed by Mr. Perret upon the design of motors for small powers, such as the driving of fans, sewing-machines, jewelers' lathes, etc.

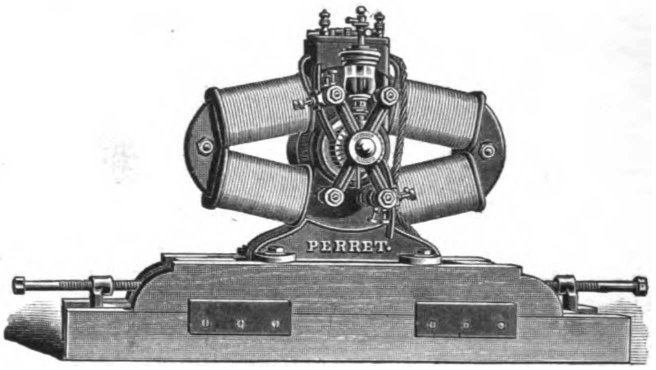


FIG. 14.—TYPE OF ¼ TO 2 H. P. PERRET MOTOR.

The same principles which have led to success in the larger machines are also embodied in these. Fig. 15 shows the manner in which the field magnets of these pygmies are built up and Fig. 16 shows a Perret ⅛ h. p. fan motor mounted on a base. Special methods of manufacture are employed in the construction of this type. For the small size of commutators employed on the fan motors, the dovetailed type of segment is not employed. In its place the commutator is built up by placing the segments on a hard rubber bushing and driving in brass pins at the ends through the bar and into the fiber. This holds the segments securely, and largely reduces the cost of manufacture. One of the features of the armatures of these machines is the peculiar spiral form given to the grooves in which the wires are wound. The pitch of this spiral is so

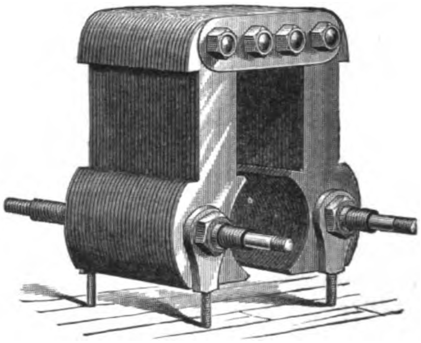


FIG. 15.—FIELD MAGNETS OF SMALL MOTOR.

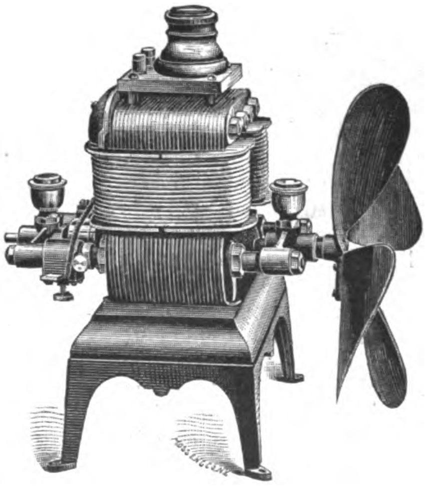
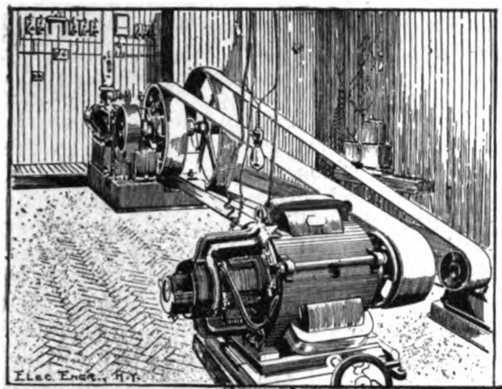


FIG. 16.—⅛ H. P. FAN OUTFIT.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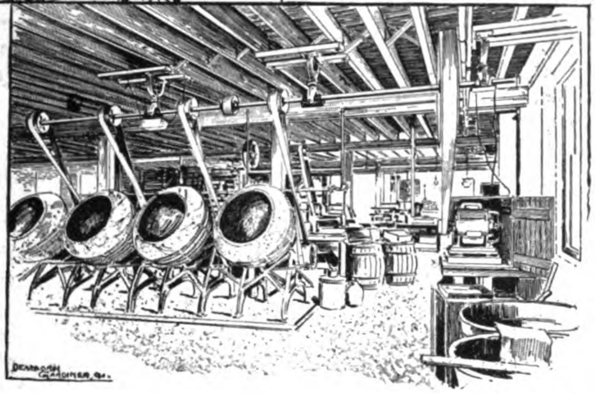


arranged that the end of one tooth leaves the edge of the pole-piece at the instant that the beginning of the next comes under it. In this way the lines of force emanating from the pole-piece are not broken abruptly, as would be the case if the teeth were parallel with the edge of the pole-piece, and as a result the action of the motor is smooth, heating of the pole-pieces is avoided, and a great deal of noise dispensed with.

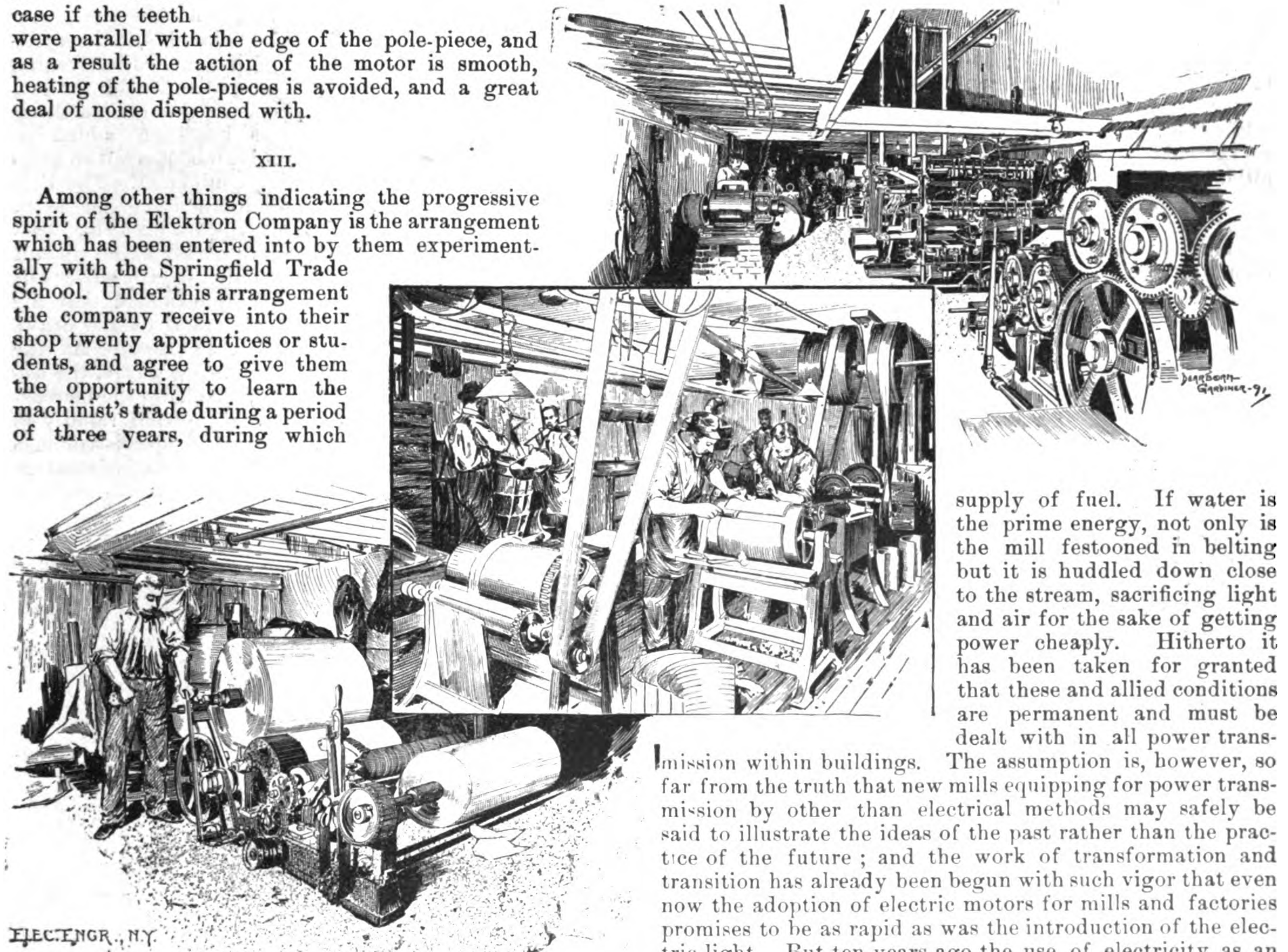
XIII.

Among other things indicating the progressive spirit of the Elektron Company is the arrangement which has been entered into by them experimentally with the Springfield Trade School. Under this arrangement the company receive into their shop twenty apprentices or students, and agree to give them the opportunity to learn the machinist's trade during a period of three years, during which the young men work in the shop one-half time and devote the other half to a special course of study in such branches as would be of most service to them in the mechanical line. The students are grouped into two divisions, one of which works one day in the shop and the other the next day and so on.

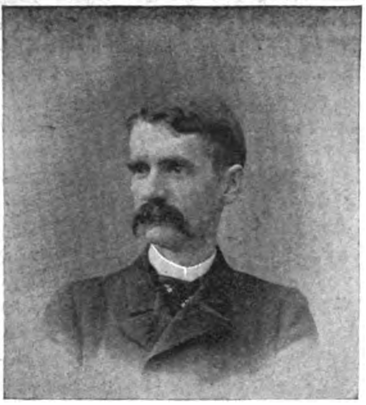
It has been a cause for regret that there has seemed to be in our present industrial system nothing to take the place of the old apprentice system which has practically passed out of existence, but this arrangement at the Elektron shops, if it proves successful, and it now appears so, will prove a solution of the problem. At all events the scheme is creditable both to the managers of the Elektron Co. and to the school. Of course the number of students at work at one time must of necessity be confined to a small percentage of the whole number of the employees, as it is not practicable to do a very large proportion of the work by students. But this new departure seems to us one of the most hopeful that has been made of late years in regard to the training of artisans, and we think it will be closely watched by economists of all schools.

XIV.

Two features are conspicuous in the construction and operation of nearly all American mills and factories at the present time. If steam is the means of distributing motive power, long and heavy lines of shafting obtrude themselves upon the eye, combined with an endless maze of belts; and the mill itself hugs closely the railroad from which it derives its supply of fuel. If water is the prime energy, not only is the mill festooned in belting but it is huddled down close to the stream, sacrificing light and air for the sake of getting power cheaply. Hitherto it has been taken for granted that these and allied conditions are permanent and must be dealt with in all power transmission within buildings. The assumption is, however, so far from the truth that new mills equipping for power transmission by other than electrical methods may safely be said to illustrate the ideas of the past rather than the practice of the future; and the work of transformation and transition has already been begun with such vigor that even now the adoption of electric motors for mills and factories promises to be as rapid as was the introduction of the electric light. But ten years ago the use of electricity as an illuminant in a mill was still a decided novelty, not a little scouted and frowned down upon. To-day it is without a rival in popularity. A similar course of events may be looked for with regard to the use of electricity for power



FIGS. 17 AND 18.—A NEW ENGLAND CANDY FACTORY, AND THE PRESS ROOMS OF NEW YORK COMMERCIAL ADVERTISER. OPERATED BY PERRET MOTORS.



W. D. Sargent.

transmission, except that the stages of advance will be the more rapid because in a great many instances the existing circuits for lighting are of capacity enough to carry ample current for motors also.

The work of the Elektron Company furnishes more than one example of this peaceful revolution now going on, and that which we here illustrate in Fig. 17 is typical in many respects. The cut shows the factory of B. H. Douglass & Sons, at New Haven, Conn. The business of this company is the manufacture of confectionery. The entire factory is operated by electric power, the plant being installed by the Elektron Company, from the plans and under the superintendence of Mr. George G. Grower, electrical engineer, of Ansonia, Conn. One of the views here given shows the 25 h. p. steam engine belted to a Perret generator, which is compound wound for 110 volts and supplies current to the Perret motors located in various parts of the works. The dynamo and the motors are all of the six-pole, low-speed type. The 4 h. p. motor on the first floor operates the elevator. A 2 h. p. on the second floor drives blowers and machines used in the manufacture of fruit tablets, which are here made in great quantities. On the third floor a 4 h. p. motor drives two cocoanut grinders; another 4 h. p. motor is used for stirring candy in the steam kettles; while the 7 h. p. motor shown in our other view is used to rotate what are called the plum pans, seven in number, although only four of them are included in the engraving. This plant has now been in operation about nine months, with a marked saving in coal consumption, and with a keen appreciation of the many advantages that electric power brings with it.

E. H. Cutler

XV.

So interesting and important is this work of electric power distribution that we may be forgiven if we direct attention to another striking plant installed by the Elektron Co., who have the honor, unless we are greatly mistaken, of being the only motor builders whose machine prints a great metropolitan daily newspaper. Our illustration, Fig. 18, shows the press rooms of the *Commercial Advertiser* of this city, where a 20 h. p. slow-speed Perret motor runs a large portion of the establishment. Early this year the idea occurred to Mr. Harold Godwin, then editor of that century-old evening paper, that it would be an advantage to use electricity to run his presses, and he did the editors of THE ELECTRICAL ENGINEER the honor of consulting them on the subject. Encouraged by the advice and information he received, Mr. Godwin lost no time in making his arrangements, and on taking possession of a large new office he installed the Perret motor, together with a Corliss engine of 50 or 60 h. p. which was to operate the supplementary apparatus and to answer as a reserve. The electrical plant was put in last April, and was started almost immediately. The equipment of the pressroom comprised a large Hoe perfecting press, capable of throwing off 25,000 copies an hour, two Cottrell presses, capable of printing 15,000 an hour each, and one wetting machine, all these being on one floor in the basement, in Park Row, and driven from a main shaft directly from the motor, without the intervention of any countershafting. Besides these heavy pieces of mechanism, there were on the floor above an outfit of regular stereotyping machinery and a 48-inch ventilating fan, all run by the same motor.

Frank A. Perret.

This Perret motor was put in by Mr. Godwin to run the single Hoe perfecting press, but it tackled that load with such a light heart that the two Cottrell presses were added. On a sudden emergency, when no steam was available, the wetter, stereo-machines and fan were also heaped on its sturdy back, but it shouldered the whole so satisfactorily that the practice has been continued. Shortly after this plant was started, Col. Cockerill bought the *Commercial Advertiser* and started the *Morning Advertiser* which has already secured so firm a footing among the popular morning dailies of New York, and for a time the motor printed both the morning and the evening editions. But the success of the morning paper soon outran the old facilities and lately a big new Hoe press has been added to which the spare Corliss engine has been connected so as to get the full benefit of the existing equipment. The Perret motor has, however, made a most striking success in keeping with the progressive journalism that it has been called upon to aid; and it is believed that at no distant date electric power will handle not only the *Advertiser* but other large dailies in this city. It may be added that the motor is on the regular 110 volt Edison circuit and draws current from the old mains along Park Row. As the readers of THE ELECTRICAL ENGINEER are aware, the use of electric motors in printing offices, thanks to the increasing availability of electric current, is growing rapidly in the larger cities of the Union, a fact which speaks volumes for the motor, in view of the delicate and difficult nature of the work, which compares in many respects, and especially in its rapid variations of load, with street railway work.

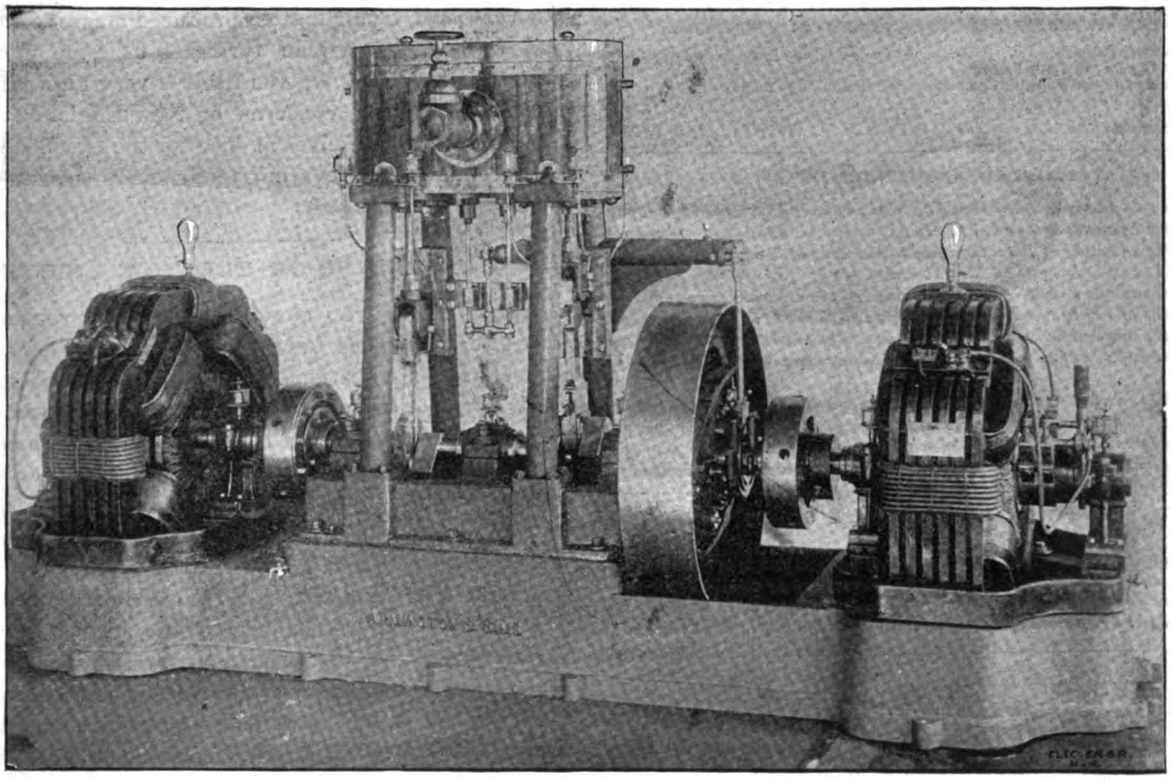
XVI.

A word by way of conclusion may not inappropriately be devoted to the personnel of the management of this progressive company, and we are glad to present here portraits of the leading officers. The president, Mr. W. D. Sargent, is not only an old telegrapher, but a pioneer telephonist, and is actively connected at the present time with the telephone companies of Long Island and New Jersey. Mr. E. H. Cutler, the treasurer and manager, has been associated with the company from the inception, and the same is true of Mr. Frank A. Perret, its electrician and electrical engi-

Leon J. Harley.

neer. Associated now with these gentlemen is Mr. Leon J. Harley, as general superintendent, a position for which a long training in the manufacture of small arms qualifies him in a special manner. The company have as selling agents, J. U. Burkett & Co., in Washington; George Baquie, in New Orleans; the Electrical Engineering Co., in Chicago; F. J. Renz, in St. Paul, and the Pennsylvania Machine Co., in Philadelphia. They have also large offices in New York under the care of Mr. Robert Watson, among whose installations may be named one of 185 lights in the building on Liberty street, where his headquarters are established, and through whom the company now have orders on hand for the equipment of a number of steamships with dynamo and engine coupled direct on one base.

The number of Perret motors now in operation in all parts of the country will figure up to several thousand and they are used for every conceivable purpose. Most of these machines are shunt wound for giving constant speed in cases where this is an important requirement, but there are many in operation that are wound to suit special work.



NEW THOMSON-HOUSTON DIRECT-CONNECTED MARINE PLANT, WITH ARMINGTON & SIMS ENGINE.

NEW THOMSON-HOUSTON DIRECT-CONNECTED MARINE PLANT.

WE illustrate in the accompanying engraving the combination of the Thomson-Houston multipolar marine dynamo with the double upright Armington & Sims engine, connected directly to the armature shaft by an insulated flexible coupling. This combination has, it is claimed, in the opinion of the Naval Board of Electrical Experts, shown greater efficiency than any other combination of the kind they have ever tested. Over sixty of these plants have been constructed which have been illustrated and described from time to time in the ENGINEER. A slight change has, however, been made from the single to the double dynamo in the steamer "Fairfax" of the Merchants' and Miners' Transportation Co.

The object of the builders was to furnish a plant as compact as possible, and the preliminary test indicated that the departure had been successful. The floor space covered by the engine and dynamos is three by ten feet, a saving of nearly one-half as compared with steamship plants previously furnished. This economy of space was gained by coupling two dynamos to one engine.

The dynamos are of the Thomson-Houston multipolar marine type, 110 volts, and each has a capacity of 10,000 watts. Both dynamos will be in service when it is desired to call into use the entire capacity of the ship, and in addition to lighting the vessel, they will supply a search light of 4,000 candle-power which is automatically operated from the pilot house. By the search light, buoys can be located from three-fourths of a mile to a mile, and the lights can be seen at a distance of fifteen miles from the vessel.

The dynamos are driven by a seven by five inch double upright Armington & Sims engine, which has a speed of five hundred revolutions a minute. The entire marine plant, which weighs seven thousand pounds, is a duplicate of those furnished the Navy Department for the new cruisers, one to three of which were placed upon each vessel. There is this difference, however; the Government engines have one dynamo connected to each engine by a flexible coupling, while the electric plant of the steamer "Fairfax" has a dynamo directly connected to each end of the engine shaft. This plant has been installed and is now in successful operation.

THE ELECTRICAL UTILIZATION OF WATER-POWER AT MARBURG.

A PROJECT is on foot, suggested by the success of the Lauffen-Frankfort experiment, for conveying 600 h. p. by electricity from Marburg to St. Lorenzen, a distance of 18 miles. A head of water, over 200 ft., is available at the former place.

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VOL. XIII. NEW YORK, JANUARY 6, 1892. No. 192.

It cannot be impressed too forcibly, both upon the student in mechanics and upon the workman, that accuracy of measurement is essential for good and efficient workmanship, and that it tends to economy in all branches of manufacture.—Sir Joseph Whitworth.

THE ART OF MOTOR BUILDING.

THE electric motor industry is still in its first decade, but it has made enormous strides and to-day constitutes one of the most active, popular and progressive fields of work in the whole domain of electricity. An evolution, strictly, of dynamo design and construction, it has yet developed many special features and principles of its own, the importance of which is daily proved in the highly ingenious and successful machines that furnish power to hundreds of different industries throughout the length and breadth of the land, either taking current from central stations or else constituting a part of some concentrated factory system of power distribution.

The art of motor construction is therefore to-day a new story, and the chapter of it presented in our description of a recent visit to the new works of the Elektron Co., at Springfield, Mass., brings out many points of great interest. The region in which these works are located is famous for the perfection of its small arms, and in various respects the electric motor belongs in the same category of fine work, intelligently designed and skilfully turned out. The motor industry, in fact, bears with its right on the sewing machine and small-arms branches of industry, and on its left is in touch with the heavy engineering of compound steam engines, and this range is one of its largest elements of promise.

A special point of interest in our article will be found in the description given of the manner in which the Elektron Co. has allied itself with the Springfield Trade School, so as to admit a limited number of students into its works for technical and mechanical training. This is an admirable departure—one, indeed, so new and novel that we do not quite see where it is likely to end. It is certainly a very ingenious and laudable attempt to give us the new system of apprenticeship of which this and every other manufacturing country so sorely stands in need; and we are glad to know that so far it is working successfully. Nowadays we hardly expect any one to go through the old seven years of drudgery that belonged to apprenticeship; but that hard, trying system produced magnificent artisans; and if the Elektron plan furnishes us some more of the old breed it will have given itself a very high rank among the manufacturing concerns of New England that have distinguished themselves at once for the excellence of their product and the elevating tendency of their social influences.

CONDENSERS IN ELECTRIC LIGHTING.

AMONG those who closely watch the progress of the times, the increasing importance of the condenser in nearly all electrical applications must have attracted more than usual attention during the last few years. This early adjunct to telegraphic apparatus has already vastly changed telegraphic methods and increased their scope, especially in submarine work; and it now bids fair to have a not unimportant bearing upon the future methods of electrical distribution of light and power. It is some years ago that Mr. S. D. Field and Mr. C. E. Fritts, in this country, and Doubrava, in Austria, called attention to the availability of condensers as direct-current transformers, at a time when the alternate-current transformer was fast occupying a field which it has now made peculiarly its own. But while thus early recognized in connection with direct-current distribution, recent developments indicate unmistakably that associated with alternate current distribution the condenser will find its more immediate and perhaps extended application. In view of this, the discussion of the condenser as a transformer of electric energy is eminently timely, and we therefore give the conclusions arrived at by Mr. Jas. Swinburne in an analysis of the subject. But besides their employment as pure converters, the important functions which they perform in alternating-current apparatus involving a lag of phase, such as we meet in the new types of alternating motors, give them an immediate interest of the highest order. If to this we add the possibility hinted at of obtaining the direct currents necessary for energizing the field magnets of alternating machines by means of condensers, and without a commutator, then indeed it must be admitted that the condenser is worthy of the most serious consideration. Nor must we forget the important part it is destined to play in the beautiful and almost ideal method of illumination of Mr. Tesla, whose experiments as detailed in his now famous lecture before the American Institute of Electrical Engineers show some of the difficulties met with in employing condensers at high potentials and frequencies. In this respect the condenser transformer will, without doubt, be made to conform to the most recent practice adopted in connection with the iron transformer, in that air will no longer be used as the insulating material, giving place in its stead, to oil. The cost of condenser apparatus for the various purposes alluded to, will to a certain extent be governed by the potentials employed, as this will determine their size, but the advantages which the use of the condenser will bring with it will probably offset this consideration in a large measure.

LOW-TENSION ALTERNATING CURRENTS FOR ISOLATED LIGHTING.

One of the earliest methods employed for isolated lighting purposes was the operation of low-tension alternating-current machines, a type which was adopted at the time principally for the reason that the machines were simple in construction and were claimed to give very good regulation. Our readers will remember that among those machines, the Ferranti-Thomson obtained considerable prominence about ten years ago. At present, however, this method machine is used for low tension. That there appears to be has been entirely discarded, and the continuous-current good reason for seriously reconsidering this method at the present time was, we think, well brought out in the interesting article by Mr. Horry appearing in our last issue. Mr. Horry, in fact, advocates the adoption of the low-tension alternating machine for isolated lighting, especially in view of the fact that we have now placed at our disposal a simple way of regulating the intensity of illumination in the lamps by means of a device which consumes no energy. While there may be those who doubt the value of this particular quality in a lamp installation, there can be no question as to the simplicity of the alternating machine and its excellent regulating qualities.

ELECTRICAL FAKES AND FRAUDS.

The paper by Mr. A. A. Knudson read by him before the New York Electrical Society last week, on frauds in the electrical business, touched an amusing and interesting subject that, as far as we are aware, had never before been handled at a gathering of the kind. The pity is that it is not possible to reach a larger audience or body of readers with it than is the case, where all to whom it is addressed are familiar with the questions involved and are not likely to suffer from imposition. Mr. Knudson makes an exposé for instance of the Scott electric hair brush; but we take it for granted that no electrician or electrical engineer uses Scott's brushes or the other fellows' belts or any other swindles of that character. As to what may be termed "frauds," namely, attempts to plunder the public through the medium of new "inventions" of alleged merit and value, it is evident that in this respect also the desideratum is to get the ear of outsiders. No electrical engineer loses his money in such a fraud as the Friend electric sugar refining, but a good many of us know people who are prejudiced against electricity because they have been big enough fools to invest without investigating. There are remedies against these fakes and frauds, and it becomes the duty of every informed man to make an exposé of such deceit wherever and whenever he encounters it, either through the ever-open columns of the scientific press, or better yet, with the help of such useful functionaries as district attorneys and such bodies as the grand jury. It is, perhaps, significant that Mr. Knudson's paper was read at Columbia College. It is to the influence of our seats of learning and of the educated men they turn out that we must look for the greatest protection and advance. A large number of people like to be humbugged and need no sympathy with their peculiar manifestation of weakness of mind; but not a few other people suffer sorely in mind, body and estate from these predatory swindlers, who take advantage of the popular belief in the ability of electricity to do anything and everything.

Cheap Street Railway Track.

It would certainly seem as if the most limited amount of common sense might by this time have taught our horse railway managers the unprofitableness of making use of the most costly kind of motive power for no better purpose than that of banging their cars to pieces against the unevennesses of a weak and flimsy track. Yet one may see to-day a new track in process of being laid in West street in this city—a location in which, to say nothing of the heavy legitimate wear, it is subjected to the incessant pounding of a never-ending procession of heavy freight trucks—in which the superstructure consists of a light side-bearing rail spiked upon longitudinal wooden stringers.

Iron in Central Station Construction.

Mr. A. E. Braddell writes us this week with regard to a point of special interest in central station construction, namely, the use of iron particularly in roofs. He states that some of the stations he has visited as an insurance inspector have suffered from the dropping of moisture from their iron roofs like a heavy dew, creating a condition of danger in the short-circuiting of the apparatus, etc. Two remedies suggest themselves. One is the construction of an inner roof of wood immediately under the iron; the other is the erection of slight sheds or awnings just over the engines and dynamos. Further and better remedies than these should lie within reach, and we shall be glad to hear from our readers on the subject. Iron is pre-eminently a material to employ in central station construction, with brick and stone, and we are slow to believe that solid or lasting objection can be found in the troubles to which Mr. Braddell calls attention.

What Shall We Do with Our Mules?

The mule is not a thing of beauty, although his efficiency is very high, and his capacity great, and when his field of labor in the lower walks of life is suddenly closed to him his usefulness is gone. When electricity usurped the place of animal power on street railways, an opportunity was afforded the horse to turn his attention to nobler things, but when canal boats are towed, and plows driven, electrically, as described recently in our pages, the mule suffers, while his manufacturers are fain to go into the motor business.

NOTES ON ELECTRIC STREET RAILWAY CONSTRUCTION.—I.

BY

A. K. McCay.

WHEN electric railroads were first introduced, the methods of different systems were quite at variance. There has been very generally, of late, a weeding out of the older and cruder methods, and nearly all systems have adopted, more or less, the good points of their rivals. So that to-day there is a similarity, and, in fact, nearly an identity, in the best railroad practice.

Beginning with the generating station, we will endeavor to refer briefly to some salient points of construction and arrangement of a successful railroad plant. If the road is to be a small one, say under ten miles, a high speed, quick-governing engine is to be preferred; as the load is very likely to vary from zero up to full load in a few moments. The engine which is generally recommended is one that has fly-wheels especially heavy, and an automatic governor sufficiently sensitive, so that variations of load are quickly compensated for. The best practice strongly recommends the use of a simple engine where condensing is not used. If water be convenient and cheap the first cost of compounding and condensing is far outweighed by the saving in coal, very often amounting to 25 per cent. In larger plants some form of Corliss engine is very generally adopted, although the writer infinitely prefers a triple or even quadruple expansion engine directly geared to the dynamo. This latter engine, usually of a vertical type, is being rapidly introduced on ocean steamers, where economy of coal means economy of operation, just as it does in an electric light or railway plant. The latest tests of this type of engine in England give a little over 1 lb. of coal per horse-power hour, so that no doubt the large railroad installations of the future will seriously consider such an engine before introducing one less economical.

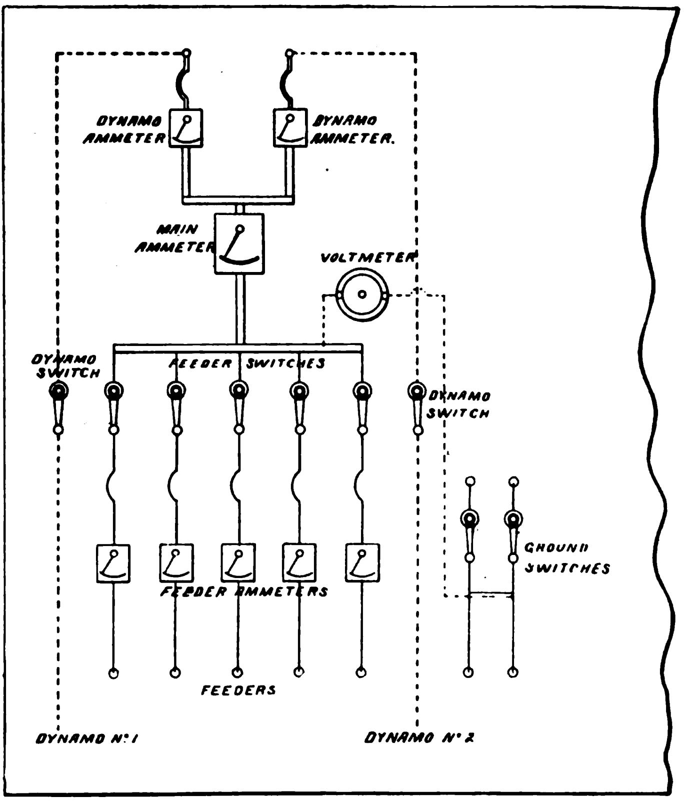


FIG. 1.—SWITCHBOARD FOR ELECTRIC RAILWAYS.

As to the dynamo, general practice has evolved a very efficient machine of the compound type, whose voltage is practically constant, and whose life is only measured by the care bestowed on it. The writer was in a large railroad plant a short while ago, and saw dynamos which have been running some eighteen months, and which are at rest just *forty-five minutes* each day, and yet the commutators were as bright, and just as large in diameter as when they began running. The application of the carbon brush practically extends the life of the dynamo indefinitely, if not heavily overloaded.

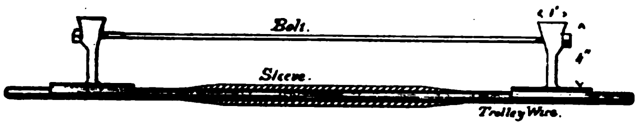


FIG. 2.—METHOD OF RELIEVING STRAIN ON TROLLEY WIRE JOINT.

Passing from the machine to the switchboard, we would recommend this to be of slate, set well away from the wall, at least four feet; and so placed as to be easy of access and perfectly safe from fire. In small stations the solid brick wall may be used; small, neat strips of wood being nailed to the wall, on which the bus bars and instruments may be secured by porcelain insulators. Fig. 1 shows the general type of a board for two dynamos. It will be noticed the main ampere meter registers the joint load when both machines are running, and checks the reading of each dynamo ampere-meter when running alone. On each feeder there is placed a fuse, a switch and an ampere-meter, so that an account can be kept of the amount of horse power required for a certain route. The wires should be brought under the floor in conduits to the switchboard and be brought from the back out to the front of the board. On installing, the board should be sufficiently large, so that additional dynamos may be connected as the business grows, as grow it will.

Passing from the switchboard to the line, we will first notice the poles. If these are of wood they should be at least 25 feet long and 7 inches in diameter at the top, and either of cedar or chestnut. In setting the poles great care should be exercised. The holes in soft dirt should never be less than six feet, while in rock formation five is permitted. Before being placed in the hole, the lower end of the pole should be coated with tar, as this will be found to materially lengthen the life of the pole. Great care should be used in setting poles. The bottom should be braced with heavy stones thrown into the hole and well rammed. The poles on a 30-foot street (between curbs) should rake some 9 inches away from the centre of the street; on a 50-foot street 14 inches will not be found too much. Special attention should be given to corner and end poles. The heaviest and stoutest poles should be chosen for these positions, and from 2 to 6 inches additional rake should be given them. Too great care cannot be given to ramming and setting

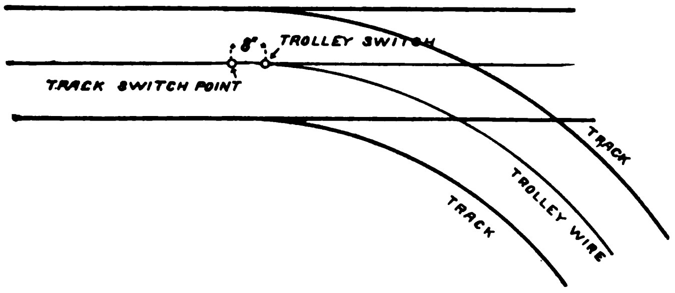


FIG. 3.—LINE CONSTRUCTION AT SWITCHES AND CURVES.

these important poles, as the life of the line and the efficiency of the service will greatly depend on this portion of the work being well done. Iron and steel poles are not given so much rake as wooden ones, because they are stiffer, and their bases are practically immovable. In setting these, care should be taken to see the concrete well rammed and that it is fresh and not set before being put around the pole.

When the poles are well set, the span wire should be strung. Modern practice is rapidly discarding the ratchet for the turnbuckle, which, to the writer's mind, is a very sensible move. Larger wire is also being used; some advocate ⅜ inch diameter, which, while to my mind it is excessive, is certainly safe. The trolley wire will probably give no trouble except at the joints. The constant passing over of the joint by the trolley wheel seems to crystallize the solder and render it brittle. If the line is stretched taut, the cool nights of the fall and early winter contract the wire, and bring a great strain on the joints, causing the wire to break at these points, entailing delay and sometimes accident. The writer has used with good effect a device shown in Fig. 2 to prevent this; and, in fact, partially to relieve the joint. It consists of two pieces of brass, whose lower part is cast to receive the trolley wire, like a bell hanger; but whose upper part is heavy enough to have a ½-inch bolt pass through it. This bolt is usually some 16 inches long and extends from one brass piece to the other; both being soldered to the trolley on each side of the sleeve. This bolt takes the strain somewhat off the sleeve, and has been found to practically overcome the trouble of the trolley pulling loose at the sleeve.

Line switches can give a great deal of trouble if not properly placed in reference to the track switch. Fig. 3 shows the relative position and the distance between the point directly below the line switch, and the point of the track switch is given as 8 inches, a distance which has been found to give excellent results. At this distance the car is well around the curve before the trolley wheel reaches the line switch. This causes the trolley wheel to bear well over in the direction the car is taking, and the trolley wheel takes the switch without fail. With these points well adhered to, little trouble and minimum expense will be found in the operation of these branches of an electric street railway plant.

A SIMPLE HELIX TELEPHONE RECEIVER.

BY

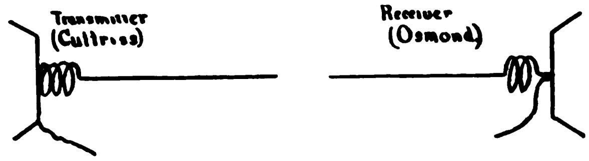
J. Thornton Osmond

Mr. Cuttriss described, in The Electrical Engineer of Dec. 16, 1891, a telephone transmitter of decidedly novel and very simple construction, and possessing superior qualities as a transmitter. I would like to call attention to a point concerning its action which he appears to have overlooked, and also to describe a very simple and mechanically similar receiver which I made in 1886, and found to have superior articulation.

In his description, Mr. Cuttriss speaks as though he regarded the action as due wholly to the change of resistance of carbon with change of pressure. I think that there is another principle which, if secondary to that named, is important in the action. I refer to the electro-dynamic action of currents in neighboring conductors. When the slight increase in pressure due to a vibration of the plate causes an instantaneous increase of current, this increasing current in the coils draws them together and thus adds to the pressure and so to the current strength. This electro-dynamic action will contribute largely to the strength of the whole action.

Perhaps I should not attach so much importance to this point but for the following experiments: In 1885, in trying to form a system for classifying telephones, it occurred to me that among the various principles of electrical action which might be used to convert the energy of the current into mechanical vibrations of similar "form," the electro-dynamic action of currents, as in a helix, had not been used. It seemed to me doubtful whether the electro-dynamic action could control the natural periodicity of the helix, and its inertia.

To test this, I made, in the early part of 1886, a rude apparatus of a bored block of hard wood, clamping a tin-type diaphragm with one end of a helix soldered to the centre. The wire was bent sharply back and then off at a right angle, as shown in the illustration. The transmitter used was sometimes the Bell (Berliner-Blake), and sometimes the Reis "bored block." It required a good deal of trial, different springs, tension, etc., to get articulate speech. Sound and pitch gave no trouble at all. But occasionally, when everything was just right, words were received with great clearness and strength.



The Helix as Receiver and Transmitter.

Of course, both Mr. Cuttriss' helix and mine, when a current passes, form magnetic fields varying with the current and acting on the diaphragm. But I found that it was possible to connect the end of the helix to the diaphragm by six or eight centimetres of silk thread without material change in the action. The proof seemed to me complete that electro-dynamic action of currents could be applied, as in a helix, for the telephonic receiver.

THE BERLINER PATENT AND THE HUNNING TRANSMITTER.

BY

Albert Stetson

The granting of Berliner's patent of November 17, 1891, seems to have called out a great deal of discussion and the expression of a variety of opinions. Some have maintained that its granting after so long an interval was an injustice, and one that would be remedied by the courts. To the writer there seems no injustice, in fact it seems entirely in accordance with the rules of the Patent Office, and its being kept in the office appears the only possible way of keeping within the spirit of our patent law. If the patent is so basic as is claimed, a great injustice would have been done by its issuance previous to the final decision by the Supreme Court on the telephone cases. Drawbaugh claimed to be the original inventor of the telephone, and while his claim was unadjudicated, it would not have been right to issue so broad a patent. How just the action of the office was, is shown by the fact that three out of seven of the Supreme Court judges were disposed to recognize Drawbaugh's claims. Whether the patent to Berliner should have been kept in the office from that time until its issue, is a question better decided inside the Patent Office than out. At all events the Commissioner seems to deserve great credit for getting it out of the office so soon after entering upon his new duties.

If it is wrong, as is urged, for patents to remain tied up so long in interference proceedings, then the remedy is not growling over specific cases, but an earnest attempt to reform some portions of our generally admirable patent laws. This would have to be done through an act of Congress, and the real friends of our patent laws would shrink from attempting any reform from fear that in reforming one pillar of the building we may pull the edifice down upon us.

Some claim that there are certain foreign patents issued to Berliner which will limit the life of his American claims to a very short period, if they have not already expired. This may be so, and in the absence of an extended search, it is impossible to say how much weight should be given to this objection. That will be a question for the courts to decide. In the absence, however, of any such test, it is well for those who expect on the expiration of the Bell patents, to reap fortunes in the telephone business to let their feet be guided somewhat by the lamp of experience.

In view of the magnificent business management that has characterized the commercial and legal conduct of the Bell Company's affairs, the idea would naturally suggest itself that the attorneys of the Bell Company were as well aware of the existence of the alleged foreign patents as any outsider could be. Looking back over the past records it will be difficult to find any great number of instances in which Mr. Storrow has been caught asleep. Many a time opposing counsel have found him very much awake, really too much so, and their clients' pocketbooks (if opposition telephone companies ever paid their bills) have suffered severely from their error of judgment as to the ease with which the Bell monopoly could be overthrown. Before venturing too far, and expending too much money, would-be telephone investors will do well to carefully examine the alleged defences.

To the writer the easiest, and apparently only safe, attack upon the telephone field, after March 7, 1893, seems to be through the Hunning patent, No. 246,512, of Aug. 30, 1881. This patent having been taken out in England on Sept. 16, 1878, will become public property on Sept. 16, 1892, and it would seem that any one will then be free to use "carbon in a state of fine loose powder, not in any way compressed or consolidated." I cannot think the Berliner patent will be possibly interpreted broadly enough to cover this use of carbon. As to the efficiency of the Hunning transmitter, Preece & Maier, in their book, "The Telephone" (page 88) say, of transmitters of this class: "It was certainly the most powerful instrument tried in England." The so-called long-distance instrument of the Bell Company is based upon the use of carbon in a free and loose state, and all know the excellence of that apparatus. With respect to the patented improvements embraced in that instrument, there are likely to be some interesting developments in the near future.

With such reliable instruments in the hands of the public as the Hunning transmitter and the Bell receiver, it would seem to be a matter of indifference whether the last Berliner patent were sustained or not.

MAGNETIC PROPERTIES OF LIQUID OXYGEN.

PROF. DEWAR recently made a highly interesting communication to the Royal Society. He sought to determine what effect a temperature of 180°C. would have upon the behavior of liquid oxygen in the magnetic field. Having previously ascertained that liquid oxygen does not moisten or adhere to rock crystal, and consequently maintains in contact with that substance a perfect spheroidal condition, he poured the liquefied gas into a shallow saucer of rock crystal, and placed it between the poles of the Faraday electromagnet. On the magnet being excited, the whole mass of liquid adhered to the poles until dissipated.

FRAUDS IN THE ELECTRICAL BUSINESS.[1]

BY A. A. KNUDSON.

THIS subject unfortunately is one of such wide scope that to cover it fully would mean the publication of a good-sized volume. For a paper of the ordinary length therefore I shall only touch upon the various branches of electricity in which impostors have left their tracks, and relate a few instances as they have come under my notice during the past few years, which will show some of their methods. We wish it understood that in speaking of impostors or "fakirs" in this paper we mean only those who, knowing an invention to be worthless, or of but little value, will attempt by false statements to induce people to put money into the same. Neither do we wish to include under this head those inventors who, honestly believing they have discovered something new and original, seek to interest capital, although their scheme may finally prove to be impracticable or previously patented.

We will now consider one or two fakir methods in the galvanic or storage battery line which as we all know has proved in the past an inviting field for that class of men. The first will be the primary battery with the electric motor. Some years ago before the advent of the dynamo, when electric motors had to depend upon the primary battery for current, a French gentleman appeared in New York with alleged new and useful improvements in both battery and motor. He had induced a relative of mine (since deceased) who was an officer in one of the savings banks to invest in the same, and had been given the use of an unoccupied room above the bank for the purpose of exhibiting the apparatus. I was asked to call and examine this "wonderful invention," for, according to the inventor, it *was* one of the greatest scientific productions of the day. The motor did not differ in principle from those already invented and published, such as that of M. Froment or of Davenport on this side of the water. In fact it was not only the same in principle as that of Froment's but nearly the same in construction.

The battery, the inventor said, was a secret, and he would not explain it. The method of demonstrating the efficiency of both motor and battery was by lifting a weight of a few pounds to the ceiling by means of a pulley and rope, the rope being wound around a drum secured to the shaft of the motor. The battery although a secret, disclosed itself soon after the motor was started, in the strong nitric acid fumes it gave out, and the active manner in which it boiled. When spoken to about the strong odor from the battery which was enough to choke one, the explanation would generally be (with an attempt to smell): "You smell anything?" Our report as you will surmise, was not favorable and we strongly warned the banker to go no further, but he had actually become so wedded to the scheme that he would believe nothing against it and all I got for my pains was a self-satisfied smile and the remark, "Well, I can believe my own eyes when I see that weight going up to the ceiling."

You will anticipate the outcome. I left them to themselves and to their own eyes; and after several thousand dollars had been sunk in the attempt to make the scheme practical, it was finally abandoned. The banker frankly acknowledged afterwards that he believed the whole thing was gotten up with the deliberate intention to deceive. So much for that wonderful motor, and the battery that was a secret.

Another case, and this will illustrate how people will sometimes put their money into a scheme, and afterwards seek advice in regard to it, was one which came under my notice a few years ago where the primary battery played a conspicuous part (although concealed in the cellar), and was, like the one in the previous case, a secret. It had for its object the production of an electric light. The gentleman who employed me to investigate this case, had, I was informed, already invested something like $20,000 in the scheme. Knowing this I certainly expected to find something at least worthy of an invention. It is a singular fact, however, and one that I have often come across, that instead of getting full and reliable advice before embarking in a venture, people will often invest their money and then afterwards, when a sense of doubt and insecurity dawns upon them, will fly to an expert.

The object of this invention, as already stated, was the production of an electric light. It was exhibited in a room ordinarily used as a dining-room in a private house. There were three or four lights placed on the chandelier and when the current was turned on, they did make a brilliant and steady light while it was being shown. It consisted of two small carbon rods placed inside a glass tube, the point of contact between the carbons being about midway between the ends of the tube which was about six inches long with a bulb at the centre. The wire from the battery connected with the carbons, and that was practically all there was to the invention. The inventor succeeded even before any patents were obtained, with his exceeding plausibility (and he was a remarkably good talker) in inducing these gentlemen to put in this large sum of money. Why, to hear this man talk was enough to deceive the very elect if they were not posted, and to show how easy some men are induced to invest in worthless enterprises of an electrical nature when in the hands of a good talker, I will give an example of the way he talked—"Edison was nowhere. For years Edison had been trying to accomplish what he had already just perfected. In Edison's system enormous capital was required in the construction of central stations, besides the cost of running expenses for fuel, labor, etc.; but in his system all of this was done away with, and for a few cents per night a whole house or store could be illuminated, and the battery would run indefinitely," and so on, ad infinitum. All of this time he was careful to conceal the fact that he was using in the battery in the cellar electropoion fluid by the barrel and zinc by the square yard in order to produce the three or four lights for comparatively short intervals of time. He told the gentlemen present and myself that there were but four cells of battery in circuit; this to me was surprising for the amount of illumination given. By a series of cross-questions we finally found out just what he had. The four cells of battery consisted of four enormous earthenware crocks, holding about 25 gallons each. Across the top of each jar or crock was placed a bar of wood to which was secured various plates of carbon and zinc running down to the bottom of the jar, so that instead of four cells or galvanic pairs in circuit, there were actually nearer 40 of very large size and the beautiful and brilliant electric light on the chandelier was duly accounted for. I do not suppose that the gentlemen who had invested their money in this scheme thought it worth while to even inquire about the battery. They saw the light, and like the banker in the former case, when he saw the weight go up and heard the inventor talk, they thought they could believe their own eyes. After the exposure was made, there was no more money invested in that scheme.

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[1] A paper read before the New York Electrical Society, Dec. 30, 1891, at Columbia College.

I could give many other instances where the impostor has manipulated the galvanic battery to his own profit; but as they would be almost repetitions of those just stated, we will pass on and look into some of the fakir's work in the electric and acoustic telephone business. I presume there is no electrical business of late years which has been so thoroughly worked by unprincipled men as the telephone business, and in order to have a better understanding of the methods of telephone sharpers, we will give a short résumé of the telephone situation as we understood it a few years ago. Where important lawsuits have been going on, the amount of fraud occasionally practiced in the attempt of one company to secure an advantage over another, would, if made known, be surprising. Bribery and false swearing has often been resorted to in some of the telephone patent suits in past years. Witnesses, experts, lawyers, and even the judge on the bench have not been entirely free from the baneful influence. I will give an instance: You may have heard of the man who was an examiner in the electrical department of the Patent Office at the time the Bell patent was issued, and who in later years for a certain sum of money made an affidavit in favor of the Bell Company setting forth certain alleged facts which occurred at that time, and who not long afterward accepted a fee from another company and made another affidavit setting forth alleged facts entirely contrary to the first sworn to. It often happens in patent suits where large amounts of money are involved, the temptation is strong to mislead and deceive, wherever such deception will be of advantage. Especially was this the case in the legal telephone fight during the attemps made to overthrow the Bell patent by attempting to show that the Reis telephone would articulate. It was well known that if the telephone invented by Reis in Germany (which ante-dated the Bell by several years) could be proved to have talked, and to have actually produced articulate as well as musical sounds, it would mean death to the Bell patent. Or if a telephone made exactly on the principle of the Reis could be shown to articulate in court, if only for five minutes, it would in all probability upset the Bell patent, the advantages of which would thus revert to public use. Hence there was abundant reason for the opponents of the Bell Company to prove if possible one thing or the other, and the utmost exertions were put forth. Germany was ransacked for relatives and those who had been acquainted with Reis during his lifetime, and affidavits and witnesses were obtained by the score, attempting to prove when, where, and how the Reis telephone talked; without doubt many of these affidavits were drawn from mistaken imaginations, while others were but partial truth. On this side of the water numbers of inventors were at work struggling for the prize in their efforts to make the thing articulate. I well remember the experience Mr. Mailloux and myself had in that direction. Night after night we worked at our homes in Brooklyn with varying success. Sometimes we would succeed in making it articulate, but our experience was, it seemed impossible to make it stay in that condition. We finally came to the conclusion that it was possible to make a Reis telephone talk, but it could not be depended upon to stay in a talking condition from one minute to another, and so far as my knowledge extends of this subject no telephone made exactly after a Reis pattern has ever been able to articulate for any length of time. When they did articulate it was probably on account of either an extremely delicate adjustment which was only temporary, or the oxidation of the contact points, thus for the time creating the variable resistance which is the life of articulation. But we could not trust it to remain in that condition over night; often did we lay it carefully one side after working for hours at night, feeling, that at last we had it, and in the morning find it as dumb as an oyster, and finally we abandoned the attempt entirely.

There was one party, however (and this is more in line with my subject in speaking of frauds) who claimed to have produced a constant talking Reis telephone, and to the consternation of the Bell Company actually showed it in a good talking condition; there could be no fault found with the articulation; it did talk and talk well, and things for a time looked blue on the Bell side of the house, until one of their experts, more observing than others, discovered a carbon button concealed in the box and in the circuit, so that it was not a genuine Reis telephone that produced the articulation, but one with the necessary modern improvement.

I once had a telephone case to investigate which will show to what extent a fake scheme will sometimes go before it finally reaches its end. There were but two papers furnished me to examine, one a copy of the patent (there was but one patent), and the other a copy of the prospectus. The claims of the patent were exceedingly limited, but the prospectus was broad enough to make up for any deficit in that respect. One clause in the patent set forth that this invention was based on the undulatory current principle, while a clause in the prospectus stated that the invention was not based upon the undulatory current theory but upon the make-and-break principle—a square contradiction on its face.

In point of fact it did not differ only in construction to the Bell telephone. The parties to whom I reported did not invest in the scheme, but other parties did, and a company was started. Their method of doing business was to manufacture the telephones here in New York, sell State rights on the patent, and establish local companies in cities and towns wherever they could, and supply them with telephones. In this way they earned in course of time sufficient money to pay a dividend on the stock and the stock advanced (a good deal of it being sold) and everything went on swimmingly; about this time I was asked by the party for whom I reported if I had not made a mistake, and they pointed to the fact that a dividend had been paid by this company. I said I thought not and advised them to wait a little longer. The Bell Company through the slow process of the courts finally reached them, and they were blotted out of existence.

A similar experience as we all know happened to a large number of other companies who attempted to compete with the Bell Company. In the acoustic telephone business it seemed at one time as though it was infested with fakirs. There seemed to be stronger inducements in the acoustic field for this class of people even, than in the electric, especially after the Bell patents had been sustained by the courts. I presume one reason was, there was no difficulty in convincing people that there was no infringement on the Bell patent, it being easy to show no electricity was used to carry the voice, and another reason was that an acoustic telephone when first put up for exhibition purposes generally worked surprisingly well. The voice could usually be heard from 10 to 20 feet away from the instrument, and the promoter would not be slow to exaggerate these advantages and almost always to characterize it as fully as important and valuable as the Bell telephone. They would say nothing about the difficulty of constructing the wire and of keeping it in repair, and in most cases those investing would hardly inquire if there were any wire at all, when in point of fact the wire is the most important part of the whole business of an acoustic telephone line. The difficulty of maintaining it is well known. In this respect this case would be similar to those above mentioned where people saw a weight go up, and saw a beautiful electric light. They thought they could believe their own eyes and when some people listened to the remarkable performances of the acoustic telephone they thought they could believe their own ears. The acoustic telephone has its place in the commercial world and in its place is most useful and convenient; but in the past it has been badly misrepresented by being exaggerated by men whose only ambition was to sell stock in fake companies

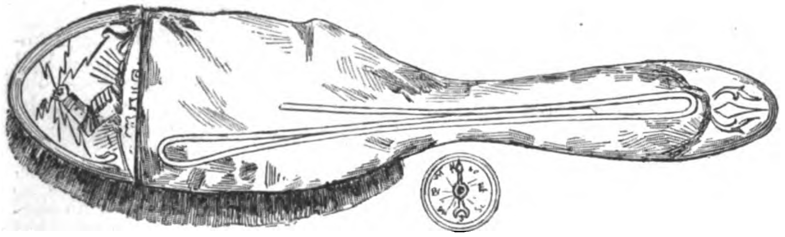
We will now leave the telephone business and pass on to the consideration of telegraph frauds. Some years ago a French Canadian appeared in Hartford, Conn., making a great stir about a new multiple telegraph system which he claimed to have invented. According to his story he could send and receive upwards of 40 messages over one wire. The duplex and quadruplex were but child's play in comparison, and so plausible were his other assertions concerning it that he succeeded in interesting some parties and finally obtaining from them a considerable sum of money for an interest in the scheme.

For a complete swindle in every detail this beat all I have ever heard of in the electrical business. It was an ingenious swindle and in order to describe it more fully I will refer to the diagram on the blackboard. A few instruments only are shown but they will be sufficient to illustrate the scheme. Several Morse sets of instruments were placed at each end of a room and a wire loop was run to New Haven, in which wire the main battery was placed. From the ends of this loop, wires were branched to one of the two binding-posts of the instruments; from the other binding-post ran a wire to all appearances to the ground, but it did not go there at all for it was purposely broken inside of the insulating covering and the ends pulled apart. Another very fine wire, however, was connected to the bottom of this same binding-post at each instrument, carefully concealed, and led to the side of the room where it was hidden entirely from view behind the paper on the wall. These fine wires all connected with the opposite instruments in their respective pair at the other end of the room. The wire in the long loop to New Haven, as you will observe, simply acted as a return ground, or one side of a metallic circuit. Under such conditions the multiple scheme, as you would expect, worked perfectly, and with any number of instruments. After the inventor had absconded with his money, which he did shortly after he got it, the instruments were removed from the room, and in doing so the fraud was discovered, for there were the wires all carefully concealed behind the wall paper.

Electrical frauds have visited the United States and plied their vocation from most every country on the face of the earth, but this man was from Canada, a country one would hardly expect to produce such a clever electrical swindler, and he showed a surprising nerve by going right into the heart of Yankeedom, in the State of Connecticut, where the people's reputation for shrewdness is so well known that it has been said, in order to dispose of some of their products such as wooden nutmegs, etc., they are compelled to go outside of the State to do it. During my sojourn in Canada for the past four years I have met but one or two who could be termed electrical fakes and they came from the States. Another phase of electrical frauds may be illustrated in a recent exhibition of a scheme in Boston.

The inventor showed a battery of peculiar construction; to the zinc pole of which was attached a wire leading out of doors to a lightning rod a short distance away. The wire from the other pole of the battery went somewhere, but supposedly to go to the ground.

The object of the scheme, according to the inventor, was to produce a constant and unlimited supply of electricity from the air. To show the practicability of the scheme a motor was placed in circuit and it ran as though it would burst; an ordinary Morse sounder was tried and that worked as though it would be torn to pieces. Mr. Frank Pope examined the scheme but was not allowed to look into it thoroughly and he said he couldn't tell just where the fake was, but it was there somewhere, and he advised the capitalist who was with him and who was in the electrical business to get some of his electricians to try and duplicate it if they could. I am sorry this scheme was not unearthed, for I believe it would prove an important addition to this paper.



Scott's "Electric" Hair Brush, with Steel Wire Exposed.

As a conclusion to this list of electrical fakes we will now consider the medical part of the business. Here we find among the so-called electrical appliances, such as belts, hair brushes, corsets, etc., gross imposition is practiced under the name of electricity upon the public and has been for years. There is hardly a complaint in the human calendar of diseases that these things, according to flaring advertisement and circulars, will not cure. To show to what an extent this imposition is practiced at the present day I will read an extract or two from a full-page advertisement taken from one of the most highly respectable magazines in this country:

> Disease is the result largely of depleted nerve force and demagnetized blood. These electro-magnetic corsets (the maker's name is here mentioned), belts, insoles and appliances have been demonstrated to be the best agency yet discovered for preventing this depletion and demagnetization as well as restoring such forces when lost. These garments are unlike any other device for electrifying the system or charging it with magnetism. As a force it is self-supplying, retaining its virtue for years and invariably benefits. These appliances so electrified can always be relied upon.
>
> These appliances promptly annihilate those weak and languid feelings, exterminate rheumatism from the system, and promptly cure the above-named disorders. They are light and comfortable to wear, and are guaranteed to imperceptibly generate a mild continuous current of electro-magnetism, all-healing in its effect. They differ from the so-called electric and galvanic belts which are usually worthless and which create sores on the body, leading to blood-poisoning. Beware of them and see that you get this one (our special make) with silver compass free. Ours are truly electro-magnetic, as any tyro in electric therapeutatics will inform you, and are absolutely reliable.

You will note the attempt is made here to work in magnetism as a curative property. Except where steel magnets are concealed of which I shall speak later), there is not one particle of magnetism produced by the action of a so-called electrical appliance of this class.

This is a point to which I wish to call special attention. Electricity properly controlled and applied is capable of wonderful effects in the relief and cure of a large number of diseases, and its legitimate use is increasing daily in the practice of the most enlightened and scientific practitioners of the age. In fact, hardly a practicing physician of any repute can be found who has not his medical batteries, some of them costing hundreds of dollars, with all kinds of electrodes, some of which are as ingenious in construction as they are humane in purpose.

It is just this point that the swindlers of to-day lay hold of and turn to their own purposes. They designedly confound electricity and magnetism, and by a skillful interchange of terms they encourage in the public mind the same confusion. In many cases where they claim that magnetism is generated by their appliances there is no magnetism at all; and in others where they claim that there is electricity there is magnetism. But this magnetism is not the result of any inherent virtue, it is the result of a smart piece of chicanery, in which the concealed magnet and the compass needle play the principal part. I claim, therefore, that in any event it is wrong and misleading to attempt to confound magnetism with the curative properties of electricity.

I have yet to learn the first case where magnetism, either strong or weak, has ever produced any effect either beneficial or detrimental upon the human system. Night after night for months I have been in the presence of the most powerful dynamos (as have thousands of men in the many electric light stations all over the world) where magnetism of the strongest kind permeates every bone and fibre and tissue of the body, and yet, so far as any effect either good or bad on the system goes, one would never know he had been in the magnetic field, and he would not notice it unless he found his watch stopped. To the best of my knowledge and belief there is absolutely nothing in the human anatomy that can be acted upon by a magnet. Of course, if a child swallows a mouthful of tacks or a paper of needles, there is something inside of the child upon which magnetism will act, but not otherwise.

What physician of any reputation has ever been known to attempt to apply magnetism, or to recommend the use of electric belts or the like? On the contrary every reputable physician with whom I have talked on the subject has denounced them as worthless. Let us go a little further into this subject, and see how some of these things will bear the light of an investigation. We will first consider the so-called electric hair brush. I have thought best to purchase one of these brushes so that we can just see how they are made and to prove the assertion that so far as any curative property is concerned they are no better than any ordinary hair brush. I will first read an extract or two from the directions pasted in the box in which it comes:

> Cures headache in five minutes; cures neuralgia in five minutes; restores the hair, prevents baldness. The "Odic force" can always be tested by moving the brush near a compass. This power is so strong that if the compass is placed upon a thick book or table and the brush is moved in a circle beneath the same the power will pass through the intervening table or book and cause the needle of the compass to rotate rapidly. A silver compass of considerable value accompanies each brush.

Now this brush I have does deflect the compass needle just as stated, but the real cause is very different from the ostensible one, and instead of any Odic force (whatever that may be) or any electricity having anything to do with its deflection, the statement is false, as I shall prove. I have taken pains to dissect the back of this brush and we find just what we expected to find. Embedded in the material of which it is composed is a steel magnet. That, and that alone, is the cause of the compass needle moving towards the brush when brought near it. When I purchased this brush I was told that the movement of the needle proved that the brush was charged with electricity, and I have no doubt everybody else is told the same thing that buys one. You will notice this magnet is made of a piece of steel wire in the form of a double loop and extends nearly to the end of the handle. The only electrical effect possible that can be produced by the use of this brush is static, and even under favorable conditions of the atmosphere, the greater part of such very small amount of static electricity as might be generated while the brush was being used would imperceptibly pass off the earth through the hand and arm and body of the user, leaving them no more benefited by its use than if they had used any other hair brush.

Electric corsets are another deception. How is it possible, I ask you, for such a thing to be of the slightest use electrically to the wearer when they are not even worn next the skin. The magnetizing of the steel ribs as is often done is of no use whatever as to any beneficial effect upon the wearer. Another of these precious frauds is the electric garter. I have seen advertisements, as no doubt many of you have, where the use of electric garters are guaranteed to give a more shapely form to the limbs of ladies. The absurdity of such an appliance is too apparent for comment but it is really too bad to disappoint and deceive the ladies in a case like that. What swindle under the name of electricity will not be attempted next? Why don't they get up an electrical hat band guaranteed to supply a lack of brains or furnish new ideas to those that wear them, yet would not such a thing be just as reasonable as some I have stated?

As an answer to some of the reckless statements which appear in advertisements and circulars, some of which I have mentioned, in regard to electric belts and other appliances I will quote an authority and read some extracts from De la Rive's "Treatise on Electricity." De la Rive was at the time of writing his work a member of the Academy of Sciences, and also of Medicine, of nearly every large city in Europe, so that he is an eminently qualified authority to pass judgment on these appliances. After explaining the construction of the electro-galvanic chains and belts of Golberger, and of Pulvermacher, he says:

> We do not very well understand the effect of this arrangement by virtue of which the current is scarcely to circulate in the chain without traversing, at least in a very sensible manner, some part of the body. For not even a derived current can be obtained on account of the imperfect conductibility of the skin. Moreover, no very positive fact has proved the efficacy of this later mode of application, upon which experience has not yet decided. And again, We do not deny that there may be a production of currents in these apparatus; even the galvanometer indicates their presence; but they are very feeble currents; and we do not see what advantages can be presented by these arrangements which at the very basis rest on false ideas of the electricity of contact.

My wonder is that the electrical journals have not been more outspoken in showing up these frauds upon the public. The public would naturally look to such a source for information of this kind, and these journals are not handicapped as others are by being paid for fat advertisements, for it is the uninformed public on electrical matters that they desire to reach; so they use the daily press and weekly and monthly publications to make known their wares. In summing up this whole matter of electrical appliances, it seems singular that they have been allowed to exist so long, especially the hair brush; one reason may be that the "public love to be humbugged"—but there is a limit to all things, and I predict, as electrical knowledge is being more and more disseminated by such institutions as Columbia College, it will not be long before people will understand the truth in regard to them.

Although I have touched upon but a few frauds and deceptions as practiced in the electrical business, I am aware of there being many more which would prove interesting were it not for the risk of tiring your patience. I have no doubt there are those in this audience who remember the electrical sugar refining frauds of a few years ago. Also the motors of Paine, which for many years continued to deceive people. Also much might be said of the tapping of telegraph wires leading to race courses, and the ingenious electrical devices and methods for supplying stock quotations to bucket shops in Wall street. Also some of the so-called telegraph schools, where young people are induced to pay their money with the promise of a situation as soon as competent. This class of fraud cannot be too strongly condemned.

In concluding this paper I cannot refrain from expressing a few words as to the position of the capitalist or investor in regard to new electrical inventions. In the few instances cited I have endeavored to illustrate how easy an investor may be deceived. It may be fairly asked by some, "Has the investor then no protection from the designs of a dishonest promoter, or from the mistaken though honest inventor?" I answer, he has. There are plenty of good, honest and capable engineers, in this and other cities, who, for a reasonable fee, will investigate and report upon any new scheme if they are only applied to. Some of these engineers are peculiarly fitted to give advice and opinions in certain branches of this business by reason of their long experience in such branches, while others have had experience, more or less, in all of them. Besides these individuals, there are now lately established in this city electrical firms composed of men of unquestionable reputation and standing, who make it their business to investigate and report upon any electrical invention; and I claim that there is now no excuse of an investor being deceived where such facilities exist for obtaining correct information upon electrical subjects. Would a man afflicted with disease undertake to cure himself if he knew nothing of the study of medicine, or would a man having an important lawsuit on his hands undertake the management of his own case if he knew nothing of the practice of law? On the same principle, then, an investor takes a large risk if he depends on his own judgment while placing his money in alleged new electrical enterprises. On the other hand, the judicious investment of capital in electrical enterprises has brought large returns to a great many people, and in very many cases handsome fortunes have been realized. As an evidence of this fact, we have but to point to the marvelous success of the Bell telephone, also the electric light (both arc and incandescent), also the electric railway. Besides these great industries, there is no end of less important schemes varying in value according to their commercial usefulness, and almost every day something new in the electrical line is being discovered.

In this paper I have endeavored to interest you by pointing out the methods of unprincipled people in the electrical business, and I have also attempted to make clear the importance of investors seeking good advice before placing their money in electrical schemes. If I have succeeded in these two points then the prime object of my paper is effected.

The paper was followed by a very interesting and amusing discussion, in which Prof. Crocker, Dr. Laudy, and Messrs. R. W. Pope, T. C. Martin and G. H. Guy participated. Several frauds and fakes were named, and Mr. Guy, as secretary, read a letter from one innocent who was being imposed upon by some persons advertising under the name of the society, and who recited a long list of swindles of which he had been the willing victim.

THE PROBABLE FUTURE OF CONDENSERS IN ELECTRIC LIGHTING.[1]

BY JAMES SWINBURNE.

It is always difficult to foretell the future in electrical engineering work, but it is sometimes interesting to try to see in what direction developments are like to take place.

The first idea of the use of condensers was to employ them like storage batteries, and mention is frequently made by the early electric light patentees of their proposed use in this way. It is needless to remark that these inventors had not the most remote idea of the vast electrostatic capacities needed for storing by the hundred ampere hours.

The project of using condensers instead of transformers is by no means dead. It has been recently taken up on scientific principles by Mr. Doubrava. As soon as a condenser is charged and discharged rapidly enough its size becomes manageable, and Mr. Doubrava is therefore working out a system in which condensers take the place of converters. This development is in good hands, and need not be discussed further. One great difficulty is in charging condensers with direct currents. A condenser of the capacity of a farad charged with one volt contains, if the expression be allowed, only half a joule. If a condenser is charged by being connected to leads at one volt half a joule is wasted over resistance and the other half is stored. The only way of charging the condenser without loss is to connect it with an electromotive force which is gradually rising. Similarly, in discharging, the electromotive force must fall gradually. This condition is not at all difficult to attain.

The greatest development of the use of condensers will probably be in connection with alternating currents. It is doubtful whether ingenuity will ever design an arrangement of condensers that will take the place of transformers in practice. In one sense there is better material to work upon. A transformer is always inefficient on account of hysteresis. The loss by "soaking in" may be taken as analogous to the loss by hysteresis, but it is infinitely less in comparison. For instance, a condenser that takes 2,000 volts and 10 amperes has a loss which is too low to measure—that is to say, it is less than 5 or 10 watts. This loss is proportional to the size of the condenser, so that small sizes are just as efficient as large. In transformers this is not the case. A 100,000 watt transformer has a loss of from somewhat less than 1,000 up to about 5,000 watts, according to the design, and if the 100,000 watts is made up of a number of small transformers the loss is much greater.

The uses for condensers are already developing. In the first place, they can be used to supply magnetizing or exciting currents to all sorts of machinery, and also to apparatus that takes lagging currents. It must be remembered that the magnetizing current in any receiving apparatus means a demagnetizing current in the generator. As an example that will soon be common, and is also striking, we may take that of running arc lamps off 100-volt circuits with choking coils in series with them. As far as the lamp is concerned, there is no better arrangement than running it off a 100-volt circuit with a choking coil in series with it to reduce the terminal pressure to about 30 volts. If such a lamp takes 10 amperes, the apparent power taken is 1,000 watts, but the real power is probably less than 300 watts. The dynamos at the station have thus to supply large "idle" currents. These not only lead to armature heating, but also demand extra excitation. If many arc lamps are used, more dynamos become necessary, as no machines will stand three times their normal armature currents, even though they are out of step with the electromotive forces. Such currents, therefore, lessen the plant output, or, as it is often loosely called, the "plant efficiency." To overcome this trouble all that is necessary is to place condensers in shunt to the choking coils and lamps, or in shunt to the high-pressure leads. The last arrangement is best, as it admits of arranging the condensers at the central station. In addition to this, condensers for 2,000 or 1,000 volts are easier to make than those for 100 volts. Condensers for such low pressures cost too much in tinfoil, and are somewhat bulky, because the dielectric has to be made thick in proportion, to make certain of the absence of flaws. At present comparatively few arc lamps are run in this manner, but that is because nearly all the alternating current systems now in use have small transformers in houses and high-pressure mains about the streets. It is probable arc lights will be run off 100-volt circuits with choking coils, and condensers will be required at the stations. Of course there is no reason why arc lights should not be run off high-pressure circuits by means of constant-current transformers. This system has never come into use in this country, probably because the low cost of this method is not generally appreciated.

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[1] Abstract from *Industries*.

It may be well to give some idea of the size of a condenser. One cubic foot of condenser will take about 2,000 volts and 5 amperes, or 10,000 apparent watts. With higher pressures the volume necessary is slightly less, and with low pressures the size increases. Below about 500 volts the bulk increases rapidly, as the volume of tinfoil is greater. The cost, therefore, increases too. It is possible to make condensers very much smaller than this; but while they are new it is best to allow a large factor of safety. Choking coils and constant-current transformers for arc lamps are not the only things requiring exciting currents. Transformers, especially if made with open iron circuits, take "idle" currents, and this can be supplied in the same way. Nearly the whole of an open circuit exciting current can be supplied by condensers. There is always some left over, because the electromotive force never varies exactly harmonically. Even if it did, there is some loss in the iron, so the no-load current cannot be reduced to nothing. In a closed circuit transformer the no-load current is less to begin with, but the active component is much greater, so that it cannot be reduced so much by condensers. It can generally be about halved.

The next use, which is analogous to those already described, is in connection with motors. Of course it is a little difficult to say what the alternate current motor of the future will be like. If it is a synchronizing machine, with the magnets excited by a direct current, it may take a leading or a lagging current, or one in step with the pressure. If it has field magnets excited by an alternate current it will take a lagging current, and condensers will be necessary. Nearly all the multiple-current motors take large exciting currents, so condensers will be necessary in their case. Take the case, for instance, of the Dobrowolsky 2 h. p. motor, as it is the only case whose figures have been published: at no load it takes 70 volts and 30 amperes at 35 periods per second. This current is presumably in each of the circuits, so that the apparent power is 4,200 watts; at full load it takes 70 volts and 100 amperes in each circuit, or 14,000 apparent watts. It, therefore, requires two condensers to reduce the apparent watts to about a tenth of these values. The enormous exciting current taken by this form of motor is one of its greatest disadvantages. A condenser to supply 14,000 apparent watts at a frequency of 35 would have a volume of four cubic feet. If the frequency is raised to 100 the exciting current increases at approximately the same rate, and so the condenser remains the same size. As there is some difficulty in making large low-pressure condensers, it is best from that point of view to put the condenser on the high-pressure side of the transformer. This, unfortunately, demands that the transformer should be 10 times the size. Thus, a 2 h. p. motor of this type would demand a 20 h. p. transformer at a frequency of 35, or a 60 h. p. at 100 periods per second. The transformers are nearly the same size in these two cases. The enormous size of the transformer is a great drawback to machines excited by alternate currents, and, unless multiple-current motors can be greatly improved, this fault alone will be enough to render them useless for most work.

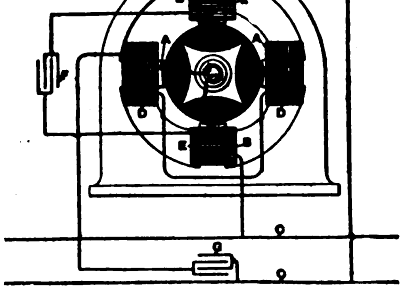


FIG. 1.

So far the condenser has been described as arranged in shunt to the circuit containing self-induction. It has then no effect on the circuit with self-induction, but affects the dynamo. In fact, it supplies exciting current instead of letting the dynamo supply it. The self-induction can, however, be counteracted by arranging capacity in series with it. For instance, suppose the alternate machine is made like one for direct currents, except that the field magnets are laminated. Suppose the machine in question is a 10 h. p. motor for 100 volts. If the field magnets are wound to suit 100 volts on a direct-current circuit, they will be only very slightly excited by the alternating pressure. If the number of turns is much reduced and the diameter increased, full excitation will eventually be reached, but the current will be enormous. For instance, if the magnets take two amperes on a 100-volt direct-current circuit, the loss in copper is 200 watts, but to drive two amperes through the inductive circuit with an alternate current would probably need something like 5,000 volts. If a few turns of large wire are used instead, the full excitation will probably be reached with about 100 amperes. Not only is the exciting current enormous, but the armature current is not in step with the field induction, so the output is lessened from this cause too. M. Leblanc was the first to point out the way to overcome these troubles by the use of condensers. A condenser may be put in series, of such a capacity that at the frequency employed the electromotive force of the condenser is always exactly equal and opposite to that of the self-induction of the magnets. This condition can only be attained approximately, as the pressure does not vary perfectly harmonically. If it did, all the electromotive force of the supply circuit would be spent on resistance, so that the same current would be produced as if the magnets were excited by a direct pressure. The field induction is then in step with the electromotive force, so that the armature current is so also, and the power taken by the motor is found by multiplying the pressure by the current.

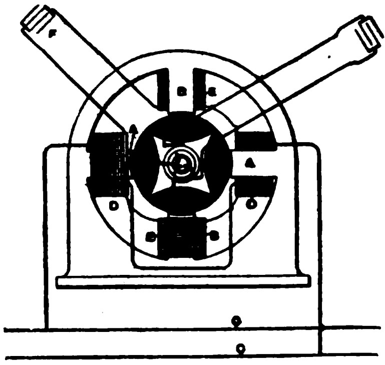


FIG. 2.

Messrs. Stanley & Kelly have designed and worked out a motor on this principle. It is constructed like an ordinary direct-current shunt motor, but has laminated field magnets. A condenser is arranged in series with the magnets. This motor has some drawbacks. In the first place, if the field magnets and armature are on a 100-volt circuit, the pressure on the condenser and on the field coils will be something like 5,000 volts, and this might make the motor too dangerous for admission to private premises. Of course this depends on the size and design of the motor. It may be possible to design a machine with much lower condenser pressure. The loss by hysteresis in the field magnets is also necessarily large; but that is not such a serious matter in a motor as in a transformer, which is on all day and all night. The next trouble is sparking at the brushes. The armature coils are short-circuited just at the time of the most rapid change of field, so that there is a large current in the short-circuited section. I would suggest that this trouble can be overcome by winding the armature with two separate circuits in parallel. The brushes then collect from both, but never short-circuit any of the sections.

The Tesla motor, as is well known, demands two or more currents differing in phase. Two currents differing a quarter of a period will do. At first special dynamos with double armature circuits were used as generators, but several arrangements involving condensers have been proposed. The first experiments of this kind were probably made by Prof. Ayrton and Dr. Sumpner. They had a small Tesla motor some years ago, but made up some arrangement with self-induction and capacity so as to split the single into a double current. The experiments have not been published, so I do not know what the exact arrangement was. Mr. Tesla has designed numerous arrangements himself; but the most complete investigations have been made by Messrs. Leblanc and Hutin, and those interested in this subject will do well to read the able articles in the *Lumière Electrique* which have been appearing recently at short intervals. These authors have gone most carefully and exhaustively into the whole subject of alternate-current motors of all sorts, and their papers are very suggestive. Fig. 1 shows a very simple arrangement due to them. One field magnet circuit E E has a condenser in series with it. Its current and induction are therefore in step with the pressure, and the wire used is the same as for direct currents under the same pressure. The other magnets A A, however, are wound with few turns of low-resistance wire B B, and take a large current, which lags practically a quarter of a period behind the pressure. In all practical cases the lag can be adjusted to a quarter of a period by using a condenser of the right capacity in the first circuit.

It is to be feared that there will be great difficulty in work-out this system to be right at various loads. As the load increases, an active current should flow in both circuits. The circuit with the condenser in series with it cannot take its load current, so that the full load output of this form of motor may be little more than half that of a double-current motor of the same size. It is probable, however, that the ingenuity of Messrs. Hutin and Leblanc in France, or Mr. Tesla in America, may overcome this drawback. A multiple-current motor is, however, thus obtained, which will work on ordinary supply circuits Only one of the sets of magnets takes a large "idle" current; but to avoid troubles from this a second condenser G in shunt to the mains C C or to the transformer that supplies the motors is advisable. This condenser is of the same cubical contents as the first, but unless arranged on the high-pressure side of the transformer it is designed for a much lower pressure and for a correspondingly larger current. By this means a self-starting motor can be obtained which has no brushes, which works on an ordinary supply circuit, and which gives full torque on starting. It has, however, the same drawbacks as the type first described. The dangerous pressure on the field coils of the first circuit may be reduced by arranging the magnet coils in small portions alternately. If the fields take 5,000 volts to drive the exciting current through, say, twelve coils, the coils and portions of the condenser may be arranged alternately, so that the maximum pressure is just over 400 volts due to the condensers. The fall over the resistance of the circuit is out of step with this, and may therefore be neglected. Mr. Tesla has also patented an arrangement on the same principle as Messrs. Hutin and Leblanc. He uses one field circuit partly as a transformer to transform up, and then places the condenser F in the secondary circuit D E D E. This seems rather to increase the difficulty arising from the very high pressures resulting from arranging condensers and induction coils in series. His arrangement is shown in Fig. 2. He has also put a condenser in the armature circuit, but it is difficult to see the inventor's object in this. Whether this form of motor is the motor of the future or not is difficult to say; but if it is, the number of condensers required will be considerable, so we are justified in discussing it at some length in this article.

There is still another possible use for condensers, and that is for exciting dynamos. An alternate machine may be regarded as made up of two elements. One has constant induction, and is called the field magnet; the other is variable, and called the armature. The field magnet may be excited by a direct current round it, or by an alternate current in the armature which is direct relatively to the field, because the armature changes position while the current changes its direction. As far as copper in the machine goes, it is cheaper to excite the fields by arranging the machine so as to have considerable armature reaction, and exciting by means of a condenser. Suppose when the field has its own coils the current density and weight of copper is the same in the field magnet and armature; if the field coils are removed and the condenser applied, the armature copper need not be doubled; it will carry the current at the same density as before, if the copper is increased in the proportion $\sqrt{2}:1$. The total power wasted is then less than before; in fact, if the armature copper is not increased at all; the loss of power in the armature alone when the condenser is used is the same as that in the armature and field magnets together, with separate excitation. By the use of a condenser, cheapness, or higher efficiency, or a compromise of these can be obtained. The condenser itself is generally much cheaper than an exciter, and is of course very much more efficient. An alternate machine with a condenser follows practically the same laws as a shunt-wound dynamo, but it has only one copper circuit, and no commutator.

Perhaps enough has been said to show that condensers may have a large future. New possibilities are appearing every day, and there is no saying what combinations of capacity, self-induction, and resistance may be invented during the next few years.

CALENDARS FOR NEW YEAR.

We have received a number of fine calendars for the New Year, and are making an æsthetic and effective disposition of them in our offices. Among them we may mention one from Mr. H. T. Paiste of Philadelphia, who, it will be remembered, has issued some very choice examples of time literature. We have also two calendars from the Commercial Cable Co. and the Direct United States Cable Co. The former is large, with a sheet pad; the latter has a leaflet pad, one leaf for each day. Pettingell-Andrews Co., of Boston, issue a large sheet calendar with big figures. The Bubier Publishing Co., of Lynn, is more modest in the proportions of its calendar, which is ornamented with a chromolithographic snow scene. The Ashton Valve Co., of Boston, have published a very tasteful calendar prepared for them by John A. Lowell & Co., who have put on it one of the finest "smooth" etchings. The Standard Paint Co., of this city, have sent us some charming little calendars for the pocket. They are printed in gold on tortoise shell, and are as useful as they are dainty. They are certainly "P. and B."—being both pretty and beneficial.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

THE HUM OF MOTORS.

FOR the benefit of Mr. Binney, I will somewhat further elucidate my theory of the cause of humming in motors.

Sound, as any one at all acquainted with physics knows, is a mode of motion produced by a peculiar vibratory movement of matter, and is transmitted by any conducting medium to the drum of the ear, and thence by auditory nerves to the brain where it is recognized as sound; and not, as Mr. Binney says, "set up by some force or forces other than those derived from motion."

I made the statement in my article that the movement in the armature was a progressive, undulatory movement of the iron; I should have said a progressive, undulatory movement *around* the circumference of the ring, not a progressive movement of the *iron;* that is, the iron does not progress, but simply has a *progressive movement*, as on waves of water the water does not progress, simply the movement. Mr. Binney seems to be unaware that all wave motion is progressive.

The intensity of attraction on any particular spot of the circumference of the ring, as it is revolving, is constantly varying, producing a vibratory movement of the iron and a progressive wave-like motion around the ring. The vibratory movement of the iron produces also a vibratory movement of the air surrounding it, which air transmits the vibration to our ears and we recognize it as sound. The wave-motion *around* the ring is undulatory and transverse to its line, or direction of propagation and is *not* sound (and I never claimed it was); whereas the vibratory movement of the iron transmitted by the air is longitudinal to its direction of propagation and *is sound.*

If Mr. Binney doubts the slightness of vibration being able to produce the sensation of sound, it would be well for him to notice the phonograph in which the little glass diaphragm appears motionless, and yet we know it vibrates and produces sound. Perhaps it would be easier for Mr. Binney to understand the action if he would imagine the poles to revolve about the armature, which would produce the same result.

I should be pleased to know what the "more admissible theories, already somewhat numerous," are.

CHAS. J. HAYES.

DETROIT, MICH., Dec. 24, 1891.

MR. STUART AND REACTIVE COILS.

THE letters by F. L. P. and Prof. Elihu Thomson, in your issue of the 16th inst., both take me to task for saying, in my article on "Reactive Coils," that Prof. Thomson first stated that if a magnetic field cut or is moved across a conductor, a current of electricity will be generated in the conductor.

Regarding the references to Faraday's "Experimental Researches" made by F. L. P., all I have to say is, that the "principle" is not stated therein. But I am aware that the principle was *known* many years ago. I do not remember that I have ever heard it *stated* except by Prof. Thomson. However, I am willing to be corrected by such eminent authority as Prof. Thomson, and the matter cannot, probably, be better stated than in his own words: "Any one who is familiar with the work of Faraday and others will understand that the principle was known many years before I was born, and is a fact so self-evident that no statement of it would be required," etc.

Concerning Prof. Thomson's next point I desire to say, first, that I am aware of the nature of his patent, No. 428,647; secondly, that I knew of the apparatus he mentions he had in his house in Lynn, and have myself operated the same; and thirdly, that I was aware of the "problematical" efficiency, so called, of reactive coils when used for such purposes.

Prof. Thomson's patent does not describe such a device as the Ries regulating socket. The device used by Prof. Thomson in his house in Lynn was not such a device as the Ries regulating socket. Nor was I considering *who* was the original inventor of the device.

In my opinion the Ries regulating socket is one of the most interesting applications of the reactive coil. I first saw this socket at the Montreal Exhibition last September. Since then I have seen it tested, and I was surprised to find its efficiency so high. My remarks on it were made because I desired to name an application of the reactive coil of the most general interest and usefulness.

The patentability of the Ries regulating socket is a matter of opinion which I will not attempt to discuss. It seems to me as worthy of a patent as many other patented devices—as worthy, for instance, as some of the regulating coils of the Thomson Electric Welding Co.

OTIS K. STUART.

PHILADELPHIA, PA., Dec. 28, 1891.

IRON ROOFS FOR LIGHT AND POWER STATIONS.

WHEN building an electric light or power plant, one of the objects in view is to have its construction as fireproof as possible. In order to secure this I know of four stations where iron roofs have been placed. These answer very well in the warm weather, but as soon as it becomes cold, very rapid condensation is the result and if not remedied very serious troubles may be caused by the water falling on machines, switchboards, etc. I know of one lighting station in particular which I visited during cold weather and found that wooden sheds had to be built over the machines in order to run them. I would ask through your numerous readers the best means of obviating this trouble, as it appears to me to be one of no little importance.

It may be a little difficult with the so-called "iron bridge" roof, but by placing a light woodwork under the rafters I should say it would answer the purpose with the least expense. Trusting you will give this a space in your valuable columns,

ALFRED E. BRADDELL,
Electric Inspector, Underwriters' Asso'n., Middle Dept.

PHILADELPHIA, Dec. 29, 1891.

REACTIVE COIL IN A KEYLESS SOCKET.

I have read with interest the various articles in regard to the reactive coil as used with a socket for the regulation of an individual lamp. It may be interesting to note that in the early part of 1889, when manager of the Gardner (Mass.) Electric Co. the writer made a small reactive coil and attached same to a keyless socket. This device was attached to the wires in the house of the vice-president of the Co., and turned down and up a lamp screwed into the socket. Owing to other work pressing this was laid aside to await a more favorable opportunity for placing it on the market. The opportunity never arrived however.

EUGENE T. CARPENTER.

FORGE VILLAGE, MASS., Dec. 26, 1891.

Society and Club Notes.

PROF. J. P. BARRETT BEFORE THE CHICAGO ELECTRIC CLUB.

A paper was read by Prof. Barrett before the Chicago Club on January 4, on "Electrical Exhibits at the Columbian Exposition." With regard to electric light and power, he stated that about 25,000 h. p. will be utilized in the shape of current in the building and grounds. He said that an important part of the electrical exhibit would be the original models and apparatus of some of the greatest inventions. As to prizes and awards, he remarked:

"It is not contemplated by the National authorities of the Columbian Exposition to offer awards which would have so great an intrinsic value as to attract exhibitors, but it is contemplated to make the standard of excellence so high that the bare acceptance of an exhibit by a department will be a lasting and distinguished honor. In the Electrical Department, the space available for exposition purposes will be so small as compared with the demand, that the greatest judgment will have to be brought into play to decide what exhibits are worthy of a place and what will have to give way. It will be impossible to accept all. Therefore the presence of an exhibit in the Electrical Building will be a testimonial of its unusual merit. The awarding committees have determined to have full and exhaustive tests made of all machinery in competitive exhibition, by the juries of the different departments, and to publish these tests and the jury findings, at the close of the exposition, under the authority of the National Commission."

NATIONAL ELECTRIC LIGHT ASSOCIATION.

WORK is being actively pushed for the convention at Buffalo next month, and there is promise already of good papers and a large attendance. One of the gentlemen who will contribute to the proceedings is Mr. Erastus Wiman, whose subjoined circular letter explains itself:

"Having had the honor of being especially designated by Mr. C. R. Huntley, president of the National Electric Light Association, to address the next convention at Buffalo, on the special subject of the financial side of electric lighting, I am desirous of all the help I can get to make a careful and strong presentation of the merits of this class of property. There is believed to be in the public mind, and especially in financial circles, a growing prejudice adverse to securities based on electrical properties. It would seem important at this juncture that as clear a view as possible should be had of the real facts of the case. Hence, it would be very desirable if I could be placed in possession of instances of successful companies, with particulars of the amounts of their stock, the length of time before dividends were paid, and the amounts regularly realized, cost of maintenance, and such other facts as can be readily got together. Some special instances of very successful concerns are particularly wished for, and the history of companies which have not at first been successful, but which have since been rescued from insolvency by good management; also any facts relating to combinations between gas and electric light companies, and how best it can be promoted.

"If you happen to have anything of that kind and can send it for me to Mr. George F. Porter, 136 Liberty street, New York, I shall be much indebted."

NEW YEAR'S EVE AT THE NEW YORK ELECTRIC CLUB.

THE entertainment at the New York Electric Club on New Year's Eve was voted a great success by all who participated in it, and the club house between 7 P. M. and 1 A. M. was visited by about 150 members. A most interesting and eloquent address on various features of journalism was delivered by Mr. Joseph Howard, Jr., a member of the club, and one of the most celebrated correspondents in the country. The address abounded in reminiscences of the elder and younger Bennetts, Horace Greeley, Henry J. Raymond, Henry Ward Beecher and others, and bristled with anecdotes and epigrams as well as with many well-directed criticisms on the less admirable aspects of modern newspaper work. Mr. Howard was listened to for over an hour with the deepest attention and received a warm tribute of applause.

The musical part of the entertainment was begun by Mr. Alfred Grünfeld, Imperial Court pianist of Vienna, Austria, who rendered a fantasia on the themes of Lohengrin and Tannhauser. The delicate touch of Mr. Grünfeld in the piano and pianissimo passages and the feeling and expression infused throughout his rendering were remarkable, and called forth well-merited applause. He was followed by his brother, Mr. Heinrich Grünfeld, Imperial Court violoncellist, of Berlin, who played a "Romanza," composed by Mr. Alfred Grünfeld. In response to a hearty encore, Mr. Grünfeld played the "Golden Wedding," by Gabriel Marie. In response to the continued and unremitting applause, Mr. Grünfeld rendered the "Guitarre" of Moskowsky. As a violoncellist Mr. Grünfeld undoubtedly ranks among the best who have thus far been heard in this country. One of the most characteristic performances of the evening was the rendering of the "Hungarian Rhapsody," composed by Mr. Alfred Grünfeld, in which he portrayed with masterly skill the peculiar intonations and effects of the Hungarian national instrument, the cymbal.

The vocal part of the programme was inaugurated by Mrs. Anna Lankow, the well-known alto concert singer and vocal teacher, who sang the celebrated aria from Gounod's "Mignon" with most consummate finish. As an encore Mrs. Lankow sang the alto aria from "Samson and Delilah." The programme was brought to a close by Sig. Victor Clodio, tenor in Gilmore's orchestral company and now of the Italian Opera Company, who sang Tosti's "Rosa" with excellent effect, his high B, *sostenuto*, calling forth enthusiastic applause. Mr. Friedberg, the well-known pianist, played the accompaniments to Mrs. Lankow and Sig. Clodio in the most finished manner.

After the regular programme had been gone through, Steward Reynolds filled the club punchbowl and served a collation. A few minutes before midnight Mr. George H. Guy played "Auld Lang Syne" on both the pianos in the club parlor, and his music was ably seconded by a large gathering of those who had lingered to see the New Year in. Steward Reynolds is entitled to much credit for the success of the arrangements in the club and for the excellence of the table d'hote dinner and later collation.

CHICAGO ELECTRICAL ASSOCIATION.

AT the regular meeting of the Chicago Electrical Association, Dec. 22, Mr. A. H. Adams read a paper upon "Chimneys and Chimney Draughts"; Mr. L. G. Bassett read a paper upon "The Speed of Electricity." The following officers were elected for six months, to begin Jan 12: President, E. G. Hovey; vice-president, J. I. Connor; secretary, F. R. McBerty, No. 227 So. Clinton Street; treasurer, Albert Scheible. This association meets the second and fourth Tuesday evenings of each month at No. 169 E. Washington street, Chicago.

GRAND RAPIDS, MICH., ELECTRICAL EXHIBITION.

GRAND RAPIDS is about to have an electrical exhibition under the auspices of the Electromathean Society. Space will be granted to manufacturers and dealers in electrical goods, for simply the payment of the expenses pertaining to their own exhibit. Some new and attractive features are promised. Mr. Eugene B. Palmer is chairman of the Committee on Advertising and Solicitation, and will be glad to furnish information to any one interested.

NEW ENGLAND ELECTRIC CLUB.

GENTLEMEN interested in the New England Electric Club have elected the following-named officers: President, Mr. Ferdinand A. Wyman; vice-president, Mr. E. A. Record; secretary, Mr. Lynn M. Hays; treasurer, Mr. A. O. Smith; board of directors, Mr. Charles C. Pierce, Mr. Maybin W. Brown, Mr. Elmer P. Morris. The officers, with Mr. E. R. Tilton and Mr. James E. Cotter, were appointed a committee on constitution and by-laws and also to take all necessary steps toward obtaining a charter, and to investigate, consider and report in regard to obtaining quarters for the club. The club starts off with a membership of 110.

Obituary.

GEORGE W. COSTER.

IN the death by pneumonia, at Schenectady, N. Y., of Mr. George W. Coster, district manager Rocky Mountain District, the Edison General Electric Company has lost one of its most faithful, efficient and zealous officers. Mr. Coster was educated at the United States Naval Academy, graduating from that school in 1867. He remained in the Navy until 1880, when he resigned and went into business. While in the Navy he acquired a thorough knowledge of discipline and of the handling of men under him, which he afterwards utilized to good purpose in civil life.

Mr. Coster was connected with the Edison interests for the past six or eight years, and his ability as an executive officer had been thoroughly demonstrated. He possessed to a marked degree the ability to surround himself with able assistants, men peculiarly fitted for their positions, and to secure from them the most devoted loyalty. His entire office was permeated with a loyalty to, and enthusiasm for, the interests of the company, which he himself served so ably and so well. Mr. Coster is not only a great loss to the Edison General Electric Company, but to his many intimate friends connected with the electrical business, who remember his warm friendship and genial manners, his death comes as a severe personal loss.

Personal.

MR. R. G. BROWN.

THE many professional and business friends of the above-named gentleman will be greatly interested in the news of his marriage to Dr. Lucy M. Hall, of Brooklyn. Mr. Brown, who is at present connected with the Interior Conduit and Insulation Co., has had an active career in telephonic and telegraphic fields in this country and abroad. Dr. Hall-Brown is a well-known and popular practitioner, vice-president of the medical alumni of Michigan University, secretary of the Department of Health, of the American Social Science Association, and has been in many positions of importance and influence.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO. vs. THE EDISON LAMP CO.—IV.

ARGUMENT OF GEORGE H. CHRISTY FOR THE UNITED STATES COMPANY.

But defendant had said further that so much of the invention as was of any practical utility, was Maxim's and not Weston's, and that all manufacturers in this country were using what was spoken of as the "attenuated-gas" treatment. Mr. Christy read Shallenberger's explanation of the attenuated-gas treatment, showing that a deposit within the pores and a deposit upon the surface went together as the inevitable result of the passage of a current through the carbon filament in the presence of hydrocarbon gas. What were the substantial marks of identity of the process? Weston's claim called for the carbon pencil, filament, illuminant; for the passage of a current to raise it to a proper temperature, and a surrounding envelope of hydrocarbon liquid or gas. With reference to what? Why, the "building up" of the carbon, by putting into it, or on to it, or both, a deposit of carbon from the surrounding carbonaceous envelope. This attenuated-gas treatment they were talking about, had every element of the Weston claim, working in the same way, with reference to the same end, and producing identically the same result. Clarke the defendant's expert, had admitted that the use of hydrocarbon vapor was a part of Weston's original invention. The point was that the use of hydrocarbon vapor constituted part of Weston's invention, whether attenuated or not. Yet defendant had tried to argue that attenuated gas—lighter gas and less of it—did not come within Weston's invention. But to go a step further, it was a fact that the oil never touched the highly heated body anyhow; it was always surrounded with vapor. If you stuck a red-hot poker into water the poker would not come in contact with the water; the heat would generate an envelope of steam around it; so it was with the red-hot carbons in oil. Although oil was one of the materials mentioned in the patent, as a matter of fact the work was actually done by hydrocarbon vapor or gas.

There was another singular fact in this case; his brother Betts had conceded that Maxim had done nothing of consequence, except perhaps making one lamp. down to 1880; that he made one lamp and took some patents. Defendant had nevertheless gone to the expense of bringing Maxim from England to examine him. In his testimony in 1891 Maxim magnifies this process; claims the credit of it himself and says that he worked it practically and publicly in 1878 But his testimony in the old interference case in the record, squarely contradicts his 1891 testimony and showed that everything he did down to 1880 had been purely experimental, and had been so admitted in his previous testimony. But Maxim, their own witness, had said that between a little less than one atmosphere and a highly attenuated atmosphere, the difference was simply a difference of degree and not of principle, exactly as he (Mr. Christy), had contended, for reasons set forth in Shallenberger's testimony. Moreover defendant did not use attenuated gas, and it did not lie in their mouth to say that something else than oil was better. They had used oil, and so far as the proof went it was the only thing they ever did use.

Referring again to defendant's brief, Mr. Christy said he had already shown that it contained erroneous statements of fact. He thought it also contained some bad statements of law. Under the heading, "Rules of Law Here Relied Upon," was this passage: "It is a fundamental principle of patent law that to entitle an alleged inventor to protection by a valid patent, it must appear that he was the first in this country to reduce the invention to a fixed, positive and practical form. That was not the law, said Mr. Christy, and it never was. The rule had been well settled by repeated adjudications, especially in this circuit, that the party who first conceived an invention, provided he used reasonable diligence in adapting and perfecting it, was the party entitled to the patent, and it made no difference who came in between. Mr. Betts' next proposition was: "Mere speculations of a party, or experiments incomplete and inconclusive in their nature, or the production of drawings or models, are insufficient to sustain the issue of prior invention when the burden is upon him to prove it. That was about as bad law as the other. Judge McKennan had said, that the first inventor might by drawings, sketches and models, carry back the date of his inception, and if he had meantime used reasonable diligence, he could thereby establish priority. The third proposition was equally objectionable and for the same reasons. There had been no citations of authorities in support of those propositions.

(To be continued.)

A QUESTION IN FIRE INSURANCE.

A CASE of much interest to insurance and electrical companies has been brought at Salem, Mass., before the Superior Court.

On the 26th of October, 1890, the night employees in the power station of the Lynn Gas and Electric Light Company discovered fire in the tower or monitor cupola over the engine-room. Attempts were made to extinguish the flames, but before it could be done the tower was charred and the main light wires burned off.

The result was a quick short circuiting of the station. So big a load was taken off the engine that it began to race, and in a very short space of time the big fly wheel was hurled in fragments through the solid brick walls of the building, carrying havoc everywhere. The station was pretty well wrecked.

It was insured for $9,000 against fire in 23 companies.

The companies refused to pay their policies because the damage and loss was from the racing of the engine, as they claimed, and not from fire.

The Lynn Electric Light Company brought suit on the ground that the damage was from fire, and that fire was the first cause, as but for the fire, the burning of the wires and the release of the engine the latter would not have run away and there would have been no explosion.

MR. R. W. POPE, secretary of the American Institute of Electrical Engineers, delivered an interesting lecture on Dec. 18, at Fitchburg, Mass., in the city hall, under the auspices of the Fitchburg Board of Trade. His subject was: "Electricity: Its Past, Present and Future."

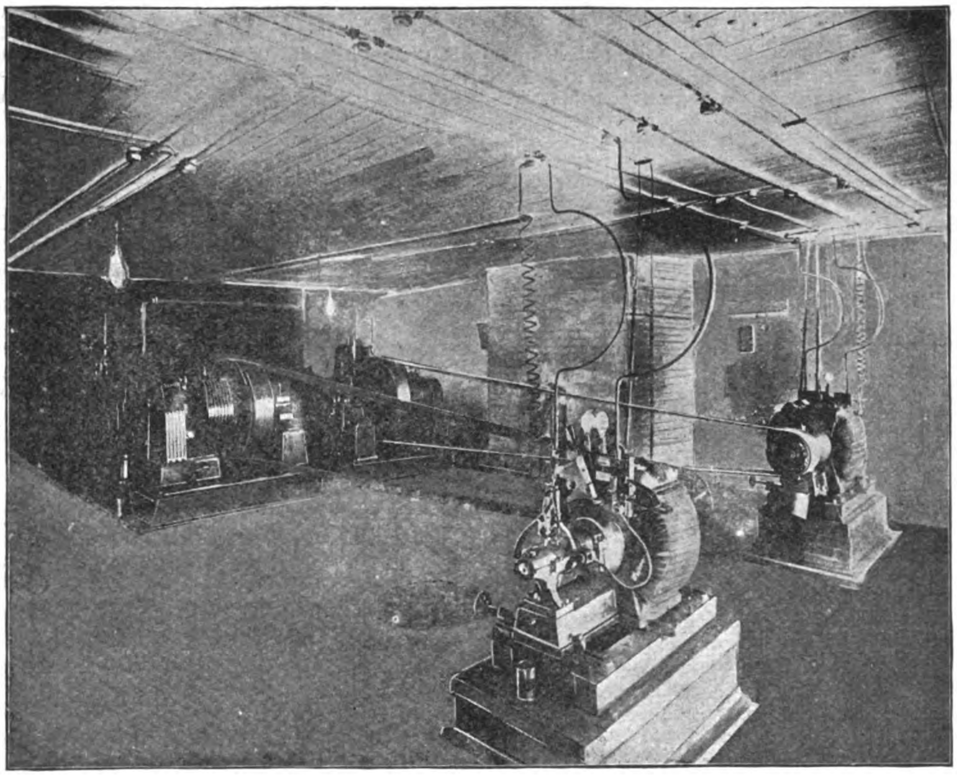
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The man who doesn't advertise is soon out of circuit or grounded.

A "C. & C." LIGHTING PLANT IN THE ST. NICHOLAS HOTEL, CINCINNATI, O.

THE illustration on this page shows the dynamo-room of the St. Nicholas Hotel, Cincinnati. The two generators have a capacity of 300 lights each and are of the standard "C. & C." type. The fields of the dynamos are compound wound and the entire machine is constructed with a view to attaining the highest possible efficiency. The armature shaft revolves in self-oiling bearings, and the whole machine rests upon a sliding base, which can be adjusted to tighten the belt. This installation was made by the "C. & C." Electric Motor Company, New York, about a year ago, and the dynamos have been in constant service since then. The fact that a 40 K. W. dynamo of the same type has recently been added to this plant to furnish current for an increased number of lights, gives evidence of the satisfaction which these machines have given.



"C. & C." LIGHTING PLANT IN THE ST. NICHOLAS HOTEL, CINCINNATI, O.

THE EQUITABLE ENGINEERING AND CONSTRUCTION CO.

THE Equitable Engineering & Construction Co., Drexel Building, Philadelphia, announce that on the 1st of January their company will go into liquidation. Their business for the past year has been a profitable one, but the active members of the concern wish to get out of the construction business.

Mr. S. Ashton Hand has accepted a position as superintendent of the Detroit Electrical Works, Detroit, Mich.. and Mr. W. A. Stadelman wishes to devote his time for the present to his interests in Bristol, Tenn., which consist of the Bristol Belt Line Railway and the Bristol and East Tennessee railroad, in both of which he owns a controlling interest.

The company retires from business with every debt paid and a good balance to be distributed as a dividend to the stockholders.

WESTERN ELECTRIC COMPANY—MORE FACILITIES?

WHEN, some eight years ago, the Western Electric Company purchased its extensive property in South Clinton street, Chicago, and erected a large building upon a part of it, it may well have been thought, even by the company itself, that abundant provision for its Western manufacturing and for its general offices had been made for a generation. Several extensive additions to the building have since proved requisite until the entire ground has been occupied, and yet more space is required for the company's constantly augmenting business. It is now reported that a purchase has been made of a block of ground adjoining the factory on the south, and known as the Collins and Burgie property, the ground measuring 300 by 200 feet.

Inquiry at the New York office of the Western Electric Co. fails to secure a confirmation of the report, and we have been unable to learn whether it is the intention of the company to erect extensive factory buildings upon the property at once, or not. It is the well-understood policy of the Western Electric Co. to maintain its manufactories within cosmopolitan cities, rather than in suburban locations near such cities, or in smaller towns. In accordance with this plan its manufacturing business is, at present, compactly located and organized in Chicago, New York, Antwerp, Berlin and in Paris.

It is also worth noting that the company has always refrained from premature announcements of its policies and intentions, preferring to await the completion of its facilities and extensions before notifying the world of them.

The report can hardly be without some foundation in fact, though we are not apprised of the purchase price of the real estate. The property includes several buildings erected by Collins & Burgie, who have conducted a foundry business on the premises for 30 years. The property can be worth scarcely less than half a million dollars, situated as it is, near the central business part of Chicago.

As the Western Electric Company has never been known to speculate in real estate, nor to undertake any piece of business just for the fun of the thing, it seems reasonable to infer that it is about to construct an extensive addition to its present Chicago factory.

F. P. LITTLE & CO.

THE above enterprising firm of electrical engineers of 141 East Seneca street, Buffalo, N. Y., have just closed a contract with William H. Walker & Co. for the installation of a 250 light Thomson-Houston incandescent dynamo and a Rice engine, for their new eight-story building on Pearl street, that city.

"P. & B" INSULATING COMPOUNDS.

A letter was recently sent by Mr. George P. Low, electrical inspector for the Pacific Insurance Union, 307 Sansome street, San Francisco, Cal, to the Paraffine Paint Co., San Francisco, who manufacture the "P. & B." insulating compounds on the Pacific coast, and for the territory west of the Rocky Mountains. The letter contained among other things, the following:—

"Permit me to express appreciation of the inestimable benefit you have conferred upon the electrical industry in perfecting and bringing out your "P & B." electrical compound. I know of nothing in the way of an insulating paint for all-around work that is compared to it."

The Pacific Insurance Union controls the entire insurance work of the Pacific coast, and early this year, Mr. Low made tests of all the insulating materials offered for sale on that coast to determine the safest insulation for the wiring of buildings. Severe tests of the compounds were made, the "P. & B." standing the tests better than anything else, and it is now compulsory that "P. & B." be used in all electrical work which comes under the control of the Pacific Insurance Union. The Pacific Postal Telegraph Cable Co. are painting their bare wires, on the Pacific coast, with "P. & B.," it having been demonstrated that wires so painted have worked perfectly during the heaviest rains, and the densest fog, while through the unpainted wires, not a tick could be heard at such times.

The Paraffine Paint Co. is the Western branch of the Standard Paint Co. of No. 2 Liberty street, this city.

THE THOMSON-HOUSTON CO. IN THE WEST.

The Chicago office of the Thomson-Houston Electric Company has just closed a contract with the Benton-Bellfontaine Railway Company, St. Louis, for the equipment of thirty cars with two motors each of their latest improved type, known as the W. P., or waterproof. The contract includes the furnishing of three 333 h. p. compound-wound generators of the Thomson-Houston manufacture, and it is understood that the railway company will do everything that is required to make this installation a model, complete and perfect in every respect.

The Thomson-Houston Company have their electric railway equipment in exclusive use in St. Louis on the following roads: St. Louis & Suburban, Union Depot, Mound City, Missouri Railroad, Suspension Bridge and East St. Louis, and it is now believed that St. Louis has more T.-H. electric railway apparatus in use than any other city in the United States, with the single exception of Boston.

ENGINEERING EQUIPMENT CO.

Facts "talk." These are facts, reported under date December 18th by the Engineering Equipment Company, of 143 Liberty street, New York. Recent shipments of Anderson's electric railway specialties—2987 "Ætna" insulators; 150 "Boston" trolleys, complete; of Anderson pull-offs, 536; terminals, 405; tree insulators, 925; hangers, 1,595; also miscellaneous shipments in considerable quantities of other Anderson specialties. All of the above were additional to direct factory orders Besides these shipments the Engineering Equipment Company report the following: 310 clips, 1,500 eye-bolts, 7,500 rail bonds, 400 turn buckles, 500 bond clamps, 625 trolley ears, 150 curve insulators, 430 trolley bells, etc. These and other materials not mentioned have been supplied to important electric railways in Massachusetts, New York, New Jersey, Pennsylvania, Georgia, Tennessee, Ohio, and in Canada.

The Engineering Equipment Company are the authorized sales agents for Messrs. A. & J. M. Anderson's reliable line apparatus and "Boston" trolleys.

OTIS K. STUART.

The above-named engineer has now established himself at the City Trust Building, Room 21, Philadelphia, where he will not only act as agent for the Germania Electric Co. in the Southeastern district, but will handle such electrical supplies as dynamos, transformers, lamps, sockets, shade-holders, etc. All who know Mr. Stuart, and are familiar with his activity and versatility will expect for him a prosperous career in his new sphere of labor.

THE BURTON ELECTRIC COMPANY.

At a meeting of the board of directors of the Burton Electric Company, held on Dec. 15 at the Citizens' Bank, Richmond, Va., the following resolution offered by Maj. Chas. R. Skinker, was unanimously adopted:

Be it resolved, That after hearing the favorable report of the superintendent, Dr. W. Leigh Burton, as regards the status of its business, we, the directors of said company, hereby desire to express our entire appreciation and satisfaction to Mr. W. R. Mason, president of the company, for the zeal manifested by him in the management of its affairs, and for his untiring efforts for the advancement of its interests; and to say, further, that we are well satisfied with the success of the enterprise up to this date.

THE SECURITY INSULATOR.

A very pretty and pithy little circular has just been issued by the Security Insulator Co., of 136 Liberty street, on the merits of their insulator, which was recently illustrated and described in our columns. The circular makes a neatly humorous statement of the good features of this insulator, the principle of which is that of the inclined plane. The wire fits snugly into the groove and is then held tightly by screwing the top cap down on it.

BALL ENGINES AT KEY WEST.

The electric light plant being erected at Key West, Florida, is a source of great curiosity to a great many of the natives, who have never seen anything of the kind before. The three large compound engines furnished by the Ball Engine Co., Erie, Pa., are the centre of attraction, the largest engine on the island, hitherto, being an antiquated 6 h. p.

THE CARD ELECTRIC MOTOR AND DYNAMO CO.

The above company, of Cincinnati, O., is now ready for business under its new incorporation. The officers are: J. W. Welshire, president and treasurer; George Bullock, vice-president; C. B. Simrall, secretary; G. B. Wilson, assistant secretary; and O. W. Jantz, electrician and superintendent. The company will push for business more actively than ever, and reports a bright outlook for the coming year.

HEAVY ELECTRIC TRACTION.

It is stated that the Illinois Central Railroad is likely to adopt electric power for the purpose of drawing its heavy trains in and around Chicago, where the smoke of locomotives has become an intolerable nuisance. It is understood that the New York Central has had a similar idea under consideration for its New York terminal tunnel. The Illinois Central has appointed two of its directors, J. W. Doane and Norman Ream, a committee to investigate and report upon the feasibility of having all trains entirely propelled by electric motors.

FACING UP GENERATOR CASTINGS.

A new portable milling machine has been designed by one of tha foremen of the Thomson-Houston Company, at Lynn, for facing up the castings of big generators. The tool is said to do in five hours the work of four days when a planer is used.—*Engineering Record.*

NEW YORK NOTES.

The Easton Electric Company, of Brooklyn, N. Y., lately sold to the Messrs. J. S. & G. F. Simpson, of 28 Rodney street, Brooklyn, N. Y., a six hundred light incandescent plant, consisting of a No. 9 Easton incandescent dynamo and the lamps. The plant includes a number of the Easton arc lamps which are operated on the incandescent circuit. The entire installation was made by the Easton Company and was pronounced a success. The plant is in daily operation on the premises owned by the Messrs. Simpson, and gives entire satisfaction. This is the sixth large plant which the Easton Company have lately installed in Brooklyn. This fact is good evidence that the work of the company is appreciated at home.

Mr. H. Ward Leonard has been called into consultation by the consolidated electric light companies of St. John, New Brunswick. When all the changes that he is to supervise and suggest are made, the company will have 180 arc lights, 5,000 incandescents, and a large power plant for running the street railway.

The Law Battery Co., of 85 John street, issued as a Christmas memento a huge stocking, which typified in a degree their own capacity for receiving orders. The stockings were greatly in demand and none have been returned as misfits.

Mr. F. V. Doty.—The marriage of Mr. Doty, the manager of the Aluminium Carbon Co., of Lancaster, N. Y., to Miss. Frances E. Olmsted is announced for January 14, at the Presbyterian Church, Geneseo, N. Y.

Walter Roach, the bookbinder, Pearl st. and Park Row, has lately put in a 5 h. p. Edison motor to run his large establishment and is more than pleased with electric power.

"A. B. C." GREETING.

WE have received from the enterprising house of Alexander, Barney & Chapin, of 20 Cortlandt st., an extremely tasteful and pretty souvenir of the season, accompanied by greetings for the New Year. It is adorned with portraits of the company's friends and "enemies." The portraits are very faithful, and the expressions will be recognized by everybody as wonderfully characteristic. The brochure is printed in colors and comes from the Bartlett press—a fact which speaks volumes for its typographic and artistic excellence.

STAR ELECTRIX.

THE Star Electrix Co. promise some new things in the way of electric lighting novelties to begin the new year. They will be put upon the market in a few days.

RECIPROCITY IN THE WEST INDIES AND SOUTH AMERICA.

THE new reciprocity treaties with the British West Indies and Salvador admit American electrical supplies and apparatus free of duties into those regions.

WESTERN NOTES.

THE ENGLEWOOD ELECTRIC LIGHT COMPANY are doing a very prosperous business in furnishing incandescent lighting in that section of Chicago, their business having increased 60 per cent. during the past year. Among other work that they have done of late, and which is well worthy of mention, is installing and furnishing current for 300 lamps in St. Cecilia Church, of Forty-fifth and Atlantic streets, for the Rev. E. A. Kelley. This church has been modeled after Notre Dame at Paris, and the lights are arranged one-half around the dome and also around the octagonal portion. On account of the distance of the lights from the station—some three miles—they have employed "boosters," manufactured by the Westinghouse Company, to give the required voltage at the lamps, making it a very interesting plant.

ELECTRIC APPLIANCE CO.—Any one happening into the busy store of the Electric Appliance Company during the last week of December would have wondered at the unusually busy appearance of the place which at no time since the new firm started has been anything but busy. The president of the company, Mr. Willard W. Low, had just returned from a business trip and any one familiar with the personnel of the Electric Appliance Company knows what that means. Mr. Low filled the Electric Appliance Christmas stocking with orders that made holiday week a very restless one for the employés of the company and a merry one for the firm.

ELECTRICAL SUPPLY CO.—Any device that is simple and which contributes to the ease of operating the dynamo is generally welcomed by practical engineers. The Wirt dynamo brush seems to have been a particularly happy design in this respect. The Electrical Supply Co., Chicago, who are the manufacturers, say that they have met with unusual success in introducing it. Engineers who have tried it say that it entirely prevents sparking and the consequent wear of the commutator. Each set is made to order. In this way they are certain to meet the exact conditions of service where used and give the greatest satisfaction.

THE ELECTRICAL SUPPLY CO., Chicago, the Western agents for the well-known "Boston" trolley, report a very marked increase of orders since the announcement of a reduction in price. They keep a full line of complete trolleys and parts in stock. They are also manufacturing a superior grade of raw-hide pinions which are meeting a ready sale. The general inclination of the trade is toward a better quality of supplies, and it is among this class of purchasers the Electrical Supply Co. find their largest buyers.

SOME QUICK WORK has recently been done in connection with the rearrangement of the Chicago Arc Light & Power Company's station recently destroyed by fire. On December 8, this company placed an order with the Chicago offices of the Pond Engineering Co. for a 200 h. p. Armington & Sims engine. The engine was shipped, complete, from St. Louis on the 9th inst. The railroad company delivered it in Chicago on the 14th inst., and on the 17th inst. the engine was ready for operation, and is now regularly driving six 50-light arc dynamos.

MR. F. E. DRAKE is now the selling representative of the Standard Electric Co., manufacturers of arc and incandescent systems of lighting, power generators and motors, at 313 to 317 So. Canal street, Chicago. Mr. Drake is an old telegraph operator, but for a number of years past has been interested in mining engineering in the West, and later in electrical work.

THE ELECTRIC APPLIANCE COMPANY are meeting with splendid success in introducing the New England switch to the Western trade and already report large sales. The Electric Appliance Company have inaugurated what we think a new departure in the electrical supply business; that is, the publishing of a catalogue especially devoted to toys and novelties for the holiday trade. About December first they printed quite an elaborate little catalogue of this character which they have distributed all over the country through the medium of the young people's periodicals, and which is bringing in quite a valuable trade in a small way. The Electric Appliance Company certainly deserve credit for this original idea and in placing before the people in general an opportunity of securing reliable electrical toys and novelties in the electrical line, as heretofore this business has been left to irresponsible dealers and the purchasers have been imposed upon to a large extent.

MR. ERNEST L. CLARK, widely known in electrical circles, has resigned as secretary of the Illinois Electric Material Co. He has organized the Ernest L. Clark Co., which will commence business the first of the year handling poles, ties, cross-arms and all kind of wooden material for electrical construction work. Mr. Clark's many friends will wish him the full measure of success in his new venture, returning as he does to his old line of business in which in the past he achieved an extended reputation and success.

THE RACINE HARDWARE MFG. CO., of Racine, Wis., have just received a second order from the Colorado Smelting and Mining Company, of Butte, Montana, for a 15 h. p. automatic engine for driving an electric lighting plant. This company have had a 10 h. p. of the same make at work for some time and the repeat order is the result of the excellent satisfaction given by this first engine.

MR. GEO. A. MCKINLOCK has returned, with his wife and infant daughter, to Chicago, from his wedding trip around the world, on which he has been gone for more than a year. He will resume his interests in the Central Electric Company and will be back shortly at his desk.

MR. CHAS. E. GREGORY, dealer in standard makes of dynamos, lamps and motors, has leased a floor at 205 So. Canal street. He furnishes machines of all makes and sizes, either new or second-hand, and also pays attention to installing of electrical plants of all kinds.

MR. L. K. COMSTOCK, the Rookery, is doing a general consulting electrical engineering business. He prepares plans and specifications for all kinds of electrical work and supervises the same. Mr. Comstock is meeting with good success here.

THE CENTRAL ELECTRIC COMPANY recently made the heaviest shipments yet in Swan incandescents. They are filling large orders right along, and the large and varied stock they carry enables them to make exceedingly prompt shipments.

CUTTER'S PLUG HAT INSULATOR. One of the odd orders lately received by George Cutter called for "those plug hat insulators that keep the ceiling white." Many who know his E. L. insulator may have other epithets for it.

GEN. C. H. BARNEY, of New York, was a visitor to Chicago, last week, He called at the Western office of THE ELECTRICAL ENGINEER. He was much interested in the progress being made on the World's Fair work.

PROF. D. C. JACKSON, instructor of electrical engineering of the University of Wisconsin, at Madison, Wis., was in Chicago, last week, visiting his many friends among the electrical fraternity.

MR. J. G. BECKERLEY, 229 So. Franklin street, is placing on the market a noiseless back-pressure valve for exhaust steam-heating purposes. It is a very simple and effective device.

THE CENTRAL ELECTRIC COMPANY are sending their friends their handsome calendar for 1892, and shall be glad to hear from those who are not supplied, so that they can be furnished.

THE CENTRAL ELECTRIC COMPANY have ready for distribution a handsome lithographed circular of the Bryant specialties, which have earned such a well-deserved reputation.

MR. C. A. BENTON, manager of the railway department of the Detroit Electrical Works, was a welcome visitor to Chicago last last week.

MR. N. P. SENAT, formerly connected with the *Street Railway Gazette*, of Chicago, has accepted a position with the *Chicago Herald.*

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XIII. JANUARY 13, 1892. No. 193.

AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—I.

BY

Mary A. Henry

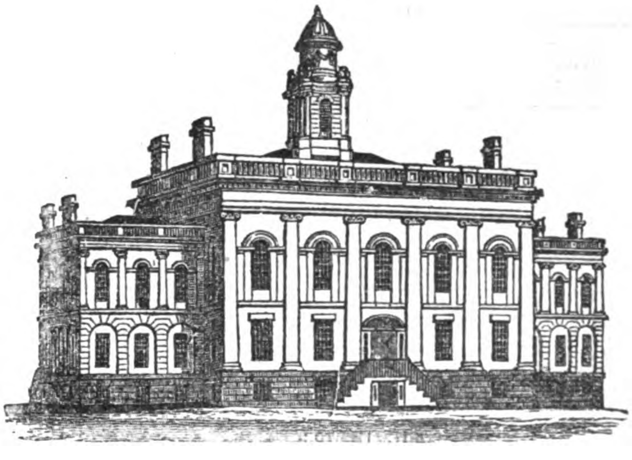
THE phenomena of self-induction and of mutual induction are closely connected, and indeed must be treated together as one whole in the modern theories of electricity and magnetism. After the discovery of self-induction by Henry, it seems to me but a step to the discovery of magneto-induction. This step was moreover made easy by the construction by Henry of electromagnets with great numbers of coils of wire. With a suitable galvanometer, also constructed with many turns of wire, there was sufficient residual magnetism in Henry's large electromagnets to give deflections of the galvanometer when the armature of the magnet was moved on or off the poles of the electromagnet, even when the latter was not excited by a battery.

MICHAEL FARADAY.

JOSEPH HENRY.

From a careful survey of the evidence presented, I believe that *Henry was the first to perceive the fluctuations of the galvanometer due to magneto-induction*, and that he had a conception of the relations of magnetism and electricity before Faraday published his first paper on the subject of magneto-induction. Henry has himself stated that he had perceived the phenomena of magneto-induction, and had been intending to study them further; but was prevented from pursuing the subject by unavoidable interruptions, and the desire to construct more powerful apparatus to continue his investigations. When we reflect that he had to insulate his wires with calico cloth, and to wind all his own electromagnets; that he was pursuing his investigations in Albany—then little more than a frontier town—while Faraday was at the Royal Institution, in the intellectual centre of the world, we feel that too much cannot be claimed for our countryman.—JOHN TROWBRIDGE.

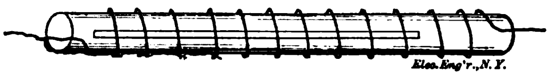
IN the year 1774, a question of no small significance was presented as a subject for prize essays by the Academy of Bavaria. The subject was one which even at that early day had excited deep interest in the scientific world; it was no less than "the identity of the two great mysterious forces, electricity and magnetism." The essays received in the competition were so numerous as to make 13 large folio volumes of matter, but the report of the Academy nevertheless was to the effect that "although electricity and magnetism are by some experimenters proved to be the same in some respects, in other respects they are dissimilar, so much so that they must of necessity be as yet considered as distinct." In this indeterminate state the matter rested for 56 years, until 1819, when, by the deflection of a needle Oersted became immortal. While the Danish philosopher was one day lecturing to his class in the University of Copenhagen, an experiment occurred to him and he tried it then and there for the first time. It was a simple matter; nothing more than the passing of a galvanic current through a wire parallel to and above a magnetic needle. Oersted found that under these conditions, the needle, swinging upon its pivot, turned eastward, and at length came to rest at right-angles to the wire, its north pole pointing east. When the wire was held below the needle, the north pole turned westward, and settled pointing west. What had happened here? What was there in this mere swaying of a bit of steel through an inch of distance to bring fame to a philosopher like Oersted? The little needle was not a common needle, a mere unresponsive fragment of steel. Endowed with the mysterious principle of magnetism, it had as one might say, a soul, and as human soul answers to human soul, it was quick to respond to another magnetic soul. Had an ordinary magnet been brought to bear upon it, in obedience to the magnetic instinct, it would have excited no surprise, had it responded to its influence. What then, we ask again, had happened in the experiment of Oersted? The little needle was behaving exactly as if the wire traversed by the electric current possessed magnetic properties. Was this, in truth, the case? Had electricity produced magnetism in or about the wire? Or was electricity itself magnetism? Oersted published four quarto


THE ALBANY ACADEMY, AS IT APPEARED IN 1826–32. FROM A CONTEMPORANEOUS WOOD-CUT.

pages on the subject;[1] the fame of his experiment spread with almost unexampled rapidity throughout the civilized world; it was repeated everywhere, and Schweigger seized upon the little needle to make of it the gavanometer,[2] so indispensable in the laboratory of the electrician from that day until this.

Very brilliant were the scientific men in the old world of that day, and about the year 1820 not a few of them were deeply interested in the question of the "identity of electricity and magnetism."

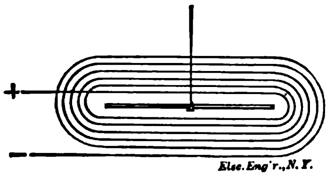
In the same year we find Arago and Sir Humphry Davy passing currents of electricity through wires and noting carefully the attractive power produced. Ampère caused two wires, each traversed by a current, to attract and repel each other, as if they indeed had been two magnets. Arago reached a result of no small importance; it was this: He placed a common steel sewing needle within a glass tube; around the exterior of the tube he wound a helical wire, through which the electric current was made to pass.



Magnetization of Steel Needle by Arago, 1820.

The needle under these circumstances was found to become strongly magnetic.[3] Nature here asserted, in most unmistakable terms, that electricity could produce magnetism. Five years later we find Sturgeon bending a bar of soft iron into a horseshoe and by an obvious adaptation of Arago's method rendering it so strongly magnetic by means of a current of electricity, as to be capable of sustaining a weight of nine pounds.[4]

There is not the shadow of a doubt, after the year 1825, that electricity can produce magnetism; but the reverse, Can magnetism produce electricity? With ever-deepening interest as year after year goes by, the scientific world asks this question, but with all the most eminent men of Europe at work upon it, nature vouchsafes no reply, and so we come down to the last days of August, 1831, and to two men, one in the old world, the other in the new, at work upon the problem, each unconscious of the other, an ocean between them. One of these men is Michael Faraday, professor of chemistry in the Royal Institution of Great Britain; the other is Joseph Henry, professor in the Albany Academy in the State of New York. These two were destined to find the key to the problem; the answer to the question which had baffled the world of science for half a century.



Schweigger's Galvanometer, 1820.

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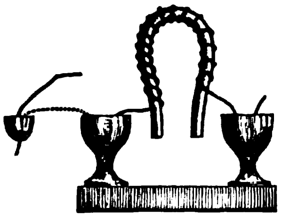

Sturgeon's Electro-magnet, 1826.

We say the last days of August, 1831, because at that date, the work of the two men nearly touch in point of time; but the actual discovery of magneto-electricity, the reader will see, if with kind patience he will follow our story, had been made by the one, that is, Henry, at least a year earlier, namely, in August, 1830, while it was not fully accomplished by the other until some thirteen months later, namely, the 24th of September, 1831; for this we shall find to be the date at which Faraday first fully recognized the phenomenon, and the principle by which it is controlled.

To understand properly the work of these two men, in reference to the discovery of magneto-electricity, it is necessary to know something of the circumstances in which they were placed. When Sir Humphry Davy was asked, which he considered his greatest discovery, he answered, "Michael Faraday." Entering the Royal Institution in an humble capacity in 1813, the flower of his genius growing and expanding under the fostering care of Sir Humphry, Faraday had attained a high position, and an enviable scientific reputation, in the great London institution. Director of the laboratory, he was surrounded by every possible facility for the prosecution of his investigations; and what was perhaps even more important, had unlimited time at his command in London, the great centre of scientific light. He was now forty years of age. Henry was nine years younger. When Faraday first entered the Royal Institution as an assistant, Henry was but thirteen. Counting the years of his age with those of the century, he had entered upon a course of original investigation as early as 1827, but amid such arduous duties as an instructor in the Albany Academy, that of all the twelve sisters of the year, he could only claim the month of August, the vacation time of the institution, as really his own. During four years he had been able to secure hardly more than as many months for regular scientific research. Could we look into his laboratory at this time, we would find, instead of the well-filled cabinets of the Royal Institution, only a few rude instruments made at great expense of time and labor by his own hands. Even the material for these rude tools was often difficult to obtain. Experiments, for instance sometimes stopped merely for the want of a scrap of zinc. We say "could we look into his laboratory," but we would seek in vain for a room which could properly be so called. Each series of experiments was necessarily carried on in the large hall of the Academy, which was available for Henry's use at no other time than during the summer vacation. Invariably all investigations came to a stop with the first of September, the beginning of the autumn session of the Academy, and were rarely resumed

Faraday's Laboratory in the Royal Institution.

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[1] A verbatim copy of Professor Oersted's original communication, in Latin, and a translation of the same may be found in *Journal of the Soc. of Tel. Engrs.*, v, 459, 464; together with a biographical sketch of Oersted by C. L. Madsden. [Editor.

[2] Schweigger's first galvanometer was a very simple affair, consisting of a small compass box, around which was coiled several turns of copper wire in a direction parallel to the meridian line of the dial. See *Schweigger's Journal für Chemie and Physik*, xxxi, 1–17. [Editor.

[3] Arago's experiments were published in *Annales de Chemie et de Physique*, xv, 93. Immediately afterwards, but before any account of Arago's experiments had reached him, Davy had also magnetized needles by the voltaic current, and by discharges of frictional electricity. He had also discovered the attractive effect of the conductor upon iron filings. His letter to Wollaston, recounting these experiments, is in *Philosophical Transactions*, 1821. It bears date Nov. 12, 1820. [Editor.

[4] *Transactions Society of Arts*, 1825, xliii, 38-52. The accompanying illustration is a fac-simile of that annexed to Sturgeon's paper.

until the month of August came again.[5] The invaluable stimulus of scientific intercourse and appreciation too, was wanting. Very different was the dull commercial town of Albany, from London, the intellectual metropolis of the world. A wide expanse of waters, not yet crossed by the swift ocean steamer, lay between Henry and all the culture of the old world, and in provincial America, little could be found to make good its place. Moreover, it must not be forgotten that Henry was the first who had undertaken a series of electrial experiments in America since the time of the immortal philosopher who first drew lightning from the clouds; "the mantle of Franklin"—said Sir David Brewster—"has fallen upon his young shoulders." Excepting Dr. Hare of Philadelphia, who was making notable improvements in galvanic apparatus, almost alone in the electric field, he stood to face the army of the old world.

Recalling the wide difference in condition surrounding the two, it is of no small interest now to see to what eminence each had at this time attained, the one during his eighteen years of culture and unimpeded work; the other in his few months of intermittent study, snatched at long intervals from the crowded days of four years of arduous professional labor. Constantly pursuing similar investigations, making many identical discoveries, Faraday and Henry seem like two competitors in a closely contested race, upon whose course we have suddenly come in these August days of 1831, and with curious eyes we scan the field to see how they are running. Bence Jones says:

> "If Faraday's life had ended at this time, when he finished his higher education, it might have well been called a noble success, but when we turn to the eight volumes of manuscripts of his *Experimental Researches* which he bequeathed to the Institution, we find that *his great work was just going to begin*."[6]

Henry had begun his course with a series of original discoveries which might well weigh in the balance with anything Faraday had as yet accomplished, while in the particular field in which lay the "*great work*" of Faraday, which he was now "*just going to begin*" he had not only entered, but was already far ahead. The mysterious phenomena of the induction of electric currents, the reciprocal production of the magnetic and electric forces, were to him already old stories, intimately familiar, singularly well comprehended by him at this early date. He is in truth but amplifying the results which Faraday has just begun to seek, in these waning days of the summer of 1831. The younger man, as it were, had struck almost immediately into this particular path, and is now almost lost to sight in it, while the elder has only just come to the spot where his entering footsteps began.

Let us dwell for a moment upon the importance of the answer to the great question we have been considering, the value to the world of the discovery made by these two men.

It is not too much to say that it constitutes a veritable epoch in electrical science; upon it depend many of the most important applications of electricity to the uses of man, and new applications are developing day by day. Tyndall, the successor of Faraday in the Royal Institution, does not attempt to restrain his enthusiasm in the contemplation of it:

> "I cannot help thinking" (he says) "when I dwell upon it that this discovery of magneto-electricity is the greatest experimental result ever obtained. It is the Mont Blanc of Faraday's own achievements. He always worked at great elevations, but higher than this he never attained."[7]

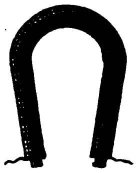
Edward N. Dickerson, the eminent advocate, said of Henry:

> "The towering heights that were scaled by the daring spirit of Faraday from the East, were at the same time surmounted from the West by our own countryman; both were climbing from opposite sides at the same time, and neither was conscious of the other's efforts till both stood face to face upon the summit."[8]

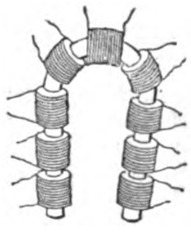
But the standard of the West had been floating many months upon these towering heights before the standard of the East was planted. It was Henry's foot, not Faraday's, which first touched the untrodden peak.

It was curious, that with such a host of the most brilliant minds of Europe at work upon the problem, the discovery which solved it was so long delayed. But there was a fact, which, it would seem almost with malicious or mischievous intent, successfully eluded all research. This fact was the necessary condition of *motion or change* for the production of the effect, and consequently the transitory nature of the phenomenon. If a magnet is thrust into the opening of a hollow helix of wire, electricity is manifested in the wire, but only for a brief instant, when the magnet is inserted and when it is withdrawn.

There is a fairy tale of a farmer's wife, whose heavy labors were lightened by a friendly gnome, who was never seen because he could never be caught at the moment he was at work. In all these years magnetism had been producing electricity under the very hands of these wise philosophers, but had never been detected in the act. *It was not caught at the moment it was at work.*



HENRY'S INTENSITY MAGNET.



HENRY'S QUANTITY MAGNET.

Let us see in what way Faraday and Henry, these two favored children of nature, ask of her the all-important question, so as to win at last a reply. Courtesy to the elder man and to the inhabitant of another country, would seem to suggest that we first go over the sea to Faraday; but this may not be, for we must look among Henry's own instruments for the stepping-stone to the great discovery, made by Henry's own hands to be a stepping-stone not only for himself but for Faraday.

Young Henry had before this time, as one of his friends has said, "made the lightning his familiar, his demon, his servitor; had lured it into his lecture-room from out of its cloud home in the thunder-storm, and tamed it so that he could bridle it, mount, ride it and spur it at will."[9]

He had taken the soft iron horseshoe of Sturgeon, with its spiral of loose uninsulated wire, an infant lifting but a few pounds at an inordinate expense of battery power, and had transformed it into a giant capable of sustaining fifty times its own weight, under the stimulus of a battery of a single pair of plates of copper and zinc, scarce a hand's breadth in area. He had made two magnets; his "intensity" magnet with a long single wire, and his "quantity" magnet with many short wires; the latter the stronger in actual physical force, but the former endowed with the subtle capacity which enabled it to respond to the electric influence at long distances; the magnet, in fact, which made the electric telegraph a commercial possibility instead of a philosopher's plaything. He had discovered and made plain the law governing the relation between the electric flow and the electric resistances in battery and magnet, and by this discovery had married, as it were, his magnets to their respective batteries; the "intensity" magnet of a long single wire to the "intensity" battery of many pairs of plates; the "quantity" magnet of many short wires to the "quantity" battery of a single large pair of plates; and had sent forth these children of his brain, through the pages of *Silliman's Journal*, to take their places as willing servitors in all the physical laboratories of the world; all this in the early days of this very year, in January, 1831.[10]

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[5] The Albany Academy, in which Joseph Henry occupied the chair of Mathematics and Natural Philosophy from 1826 to 1832, is an institution which for three quarters of a century has been held in deservedly high esteem, not alone in the community in which it is situated, but throughout the United States. Among the oldest foundations of its kind in the country, "its venerable walls seem imbued with that subtle spirit of the past, that favors study, and that nothing but time can give." The Academy building, beautifully situated on the public square near the head of State street at the right of the Capitol, is a dignified and admirable architectural example of the classical or "colonial" type. In the words of the late Dr. Meads in his oration at the semi-centennial anniversary of the Acadamy in 1863:—"Time has not rendered it in any degree unfitted for its purposes, nor unworthy of its position among the public buildings of Albany. It seems to have had a power to charm down and repress even the proverbial destructiveness of youth, and it stands to-day, after the lapse of half a century, unmarred by any spoiling hand, in all its original freshness and beauty."

The room in which Henry prosecuted his memorable experiments in electricity and magnetism, during the vacations of the Academy, has remained almost unchanged since his day. It is a lofty, well lighted and spacious hall of admirable proportions, and chaste and classical decoration, and is in no respect unworthy of the interesting associations that cluster about its venerable walls. [EDITOR.

[6] *Life and Letters of Faraday*, i, 384.

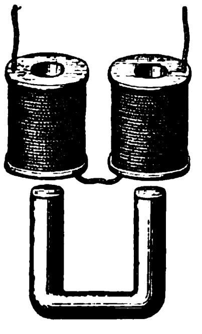
[7] *Faraday as a Discoverer.*

[8] *Joseph Henry and the Magnetic Telegraph*, p. 11.

[9] S. S. Cox, Memorial Speech in the House of Representatives Jan. 16, 1879.

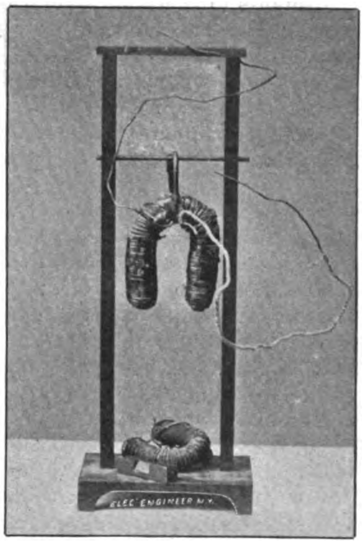
Prof. William B. Taylor says:

> "The importance of this discovery can hardly be over-estimated. The magnetic 'spool' of fine wire, of a length—tens and even hundreds of times as great as that ever before employed for this purpose was in itself a gift to science which really forms an epoch in the history of electro-magnetism. It is not too much to say that almost every advancement which has been made in the fruitful branch of physics since the time of Sturgeon's happy improvement; from the earliest researches of Faraday downward has been directly indebted to Henry's magnets. By means of the Henry 'spool' the magnet almost at a bound was developed from a feeble childhood to a vigorous manhood. And so rapidly and generally was the new form introduced abroad among experimenters, few of whom had ever seen the papers of Henry, that probably very few indeed have been aware to whom they were really indebted for this familiar and powerful instrumentality. But the historic fact remains that prior to Henry's experiments, in 1829, no one on either hemisphere had ever thought of winding the limbs of an electromagnet on the principle of the 'bobbin,' and not till after the publication of Henry's method in January, 1831, was it ever employed by any European physicist."



THE PRINCIPLES OF THE SPOOL OR BOBBIN, AS APPLIED BY HENRY TO THE ELECTRO-MAGNET.

> "But in addition to this large gift to science, Henry has the pre-eminent claim to popular gratitude of having practically worked out the differing functions of two entirely different kinds of electromagnet; the one surrounded with numerous coils of no great length, designated by him the 'quantity,' the other surrounded with a continuous coil of very great length designated by him the 'intensity' magnet. The latter and feebler system (requiring for its action a battery of numerous elements) was shown to have the singular capability, never before suspected or imagined, of subtle excitation from a distant source. *Here for the first time is experimentally established the important principle that there must be a proportion between the aggregate internal resistance of the battery and the whole external resistance of the conjunctive wire or conducting circuit.* This was a very important, though unconscious, experimental confirmation of the mathematical theory of Ohm, embodied in his formula expressing the relation between electric flow and electric resistance, which, although propounded two or three years previously, failed for a long time to attract any attention from the scientific world."
>
> "Never should it be forgotten that he who exalted the 'quantity' magnet of Sturgeon from a power of twenty pounds to a power of twenty hundred pounds, *was the absolute* CREATOR of *the 'intensity' magnet; and that the principles involved in this creation constitute the indispensable basis of every form of magnetic telegraph since invented.*"[12]



INTENSITY MAGNET MADE BY HENRY IN 1829; NOW IN THE CABINET OF THE COLLEGE OF NEW JERSEY.

It detracts nothing from Henry's independent and original discovery of the law of relation between the "electric flow" and the "electric resistance," that Ohm, in far-distant Munich, had a theoretical dream of such a law, which, with a sagacity little short of marvellous, he reduced to a concrete mathematical formula. Consider for a moment the distinction between the man who propounds a theory and the man who makes a veritable discovery; for precisely in these two attitudes stand Ohm and Henry in relation to this fundamental electric law. A theory may, it is true, be of inestimable value; but however ingenious, however founded upon intimate knowledge of the subject, it at the most can only suggest *what may be;* can only point out an intelligent mode of asking Nature a question. The theory may, or may not, prove to be true. A discovery, on the contrary, tells us *what is;* it tells us that a certain fact or a certain relation in nature actually exists. Of the theory of Ohm, now at the tongue's end of every schoolboy, but for a long time ridiculed, or at least unnoticed by the scientific world, Henry, in far-distant America, knew absolutely nothing. Five years later, in a letter written from Princeton, dated December 17, 1833, we find him asking Dr. Bache: "Can you give me any information about the theory of Ohm? Where is it to be found?" In another letter of about the same period: "Who is Ohm? What is his theory?" It was not until 1836, during his visit to London, that he sees at last Ohm's theory, and finds that, after all, it is in substance nothing more nor less than his own discovery, interpreted in the language of mathematical prophecy.

ASBESTOS PORCELAIN.

IN a recent communication to the Académie des Sciences, M. F. Garros called attention to a new form of porcelain brought out by him. He takes asbestos fibre and reduces it to a fine powder. If pure, it exhibits an exceedingly white apparence, but if traces of iron oxide are present there is a slightly yellow tint. In the latter case the oxide is removed by sulphuric or hydrochloric acid. The powder is then made into a paste, moulded into shape, dried slowly, and baked (1200° C.) from 17 to 18 hours. If placed in a very high-temperature furnace, a remarkably transparent species of porcelain is obtained. This "asbestos porcelain" has already been used for filtration and sterilization purposes, experiments showing that it is a more rapid and effective filterer than ordinary porcelain, and that the pores are less liable to become clogged up.

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[10] Silliman's *Amer. Jour. Science*, Jan. 1831, xix, 404-5.

[11] "It is evident"—says Mr. Fahie—"that it was not until after the interview with Henry [on April 11, 1837] that Wheatstone recognized the applicability of Ohm's laws to telegraphic circuits, the study of which would likewise have enabled him to ascertain the best proportions between the length, thickness, etc., of the coils, as compared with the other resistances in the circuit, and to determine the number and size of the elements of the battery necessary to produce the maximum effect." [*History of Electric Telegraphy*, p. 515.] Yet Wheatstone—characteristically, it must be said—has not hesitated to claim Henry's discovery for himself. In a statement written by him in 1841, to be presented to the arbitrators in a disagreement which had arisen between himself and Mr. Fothergill Cooke, he says:—"These methods of completing the secondary circuits have lost nearly all their importance, and are scarcely worth contending about, *since my discovery, that electromagnets may be so constructed as to produce the required effects by means of the direct current even in very long circuits.* [*The Electric Telegraph; Was it Invented by Professor Wheatstone*, ii, 96.] In a subsequent portion of the same document he nevertheless says of himself:—"Wherever I have borrowed an idea from Ohm, Gauss, Steinheil, or any other person, I have, and shall always be ready to acknowledge it." Yet Henry's paper in *Silliman's Journal*, had then been published for some years, and Henry himself had explained to Wheatstone in King's College, on April 11, 1837, the construction and use of his "intensity" magnet. In later years, however, Wheatstone became somewhat more guarded in his assertions, for we find him writing to Cooke in 1856, in reference to the same matter:—"With this law and its applications, no persons *in England* who had before, occupied themselves with experiments relating to electric telegraphs, had been acquainted." The words which we have italicized are significant, and are only capable of construction as an acknowledgment—though not a particularly graceful one—of the priority of Henry. [EDITOR.

[12] *Memorial of Joseph Henry*, pp. 226, 227.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—I.

BY

Francis B. Crocker and S. S. Wheeler.

INTRODUCTION.

THE purpose of these articles is to set forth the more important facts which present themselves in the actual handling of dynamo-electric machines and electric motors, as a guide for those who use or study these machines. The authors do not claim for this treatment of the subject that it is anything more than a set of directions in which the various points are arranged under headings for convenience of reference.

The subjects considered are: Chapter I, General Principles of Dynamos and Motors; Chapter II, Directions for Selecting; Chapter III, Installing; Chapter IV, Starting; Chapter V, Running; Chapter VI, Stopping; and Chapter VII, Testing Dynamos and Motors; also Chapter VIII, Directions for Locating and Remedying Troubles in these machines.[1]

Heretofore writers on the dynamo or motor have usually treated these machines entirely distinctly, and books or papers on the dynamo usually contain nothing about the motor, or merely consider it briefly in a few special chapters, and books on the motor only refer to the dynamo incidentally. The authors have found that there is no necessity for this separation; in fact, nine out of ten statements which apply to the dynamo are equally applicable to the motor, and if the word machine is used instead of dynamo, the statement covers both and becomes doubly important and useful. Occasionally, of course, it is necessary to distinguish between the two machines, but, as a matter of fact, the difference in treatment required for dynamos and motors is often less than for different kinds of dynamos; for example, a shunt dynamo and series dynamo differ from one another much more than do a shunt dynamo and shunt motor.

CHAP. I.

GENERAL PRINCIPLES OF DYNAMOS AND MOTORS.

Definitions.—*A dynamo-electric machine is a machine for converting mechanical energy into electrical energy;* in other words, *it generates electric current when driven by mechanical power.* The term dynamo-electric machine is so long that it is usually and unavoidably shortened into "dynamo," which has exactly the same meaning. The name "electric generator" or simply "generator" is often applied to the dynamo, especially when used to produce current for electric railway or other motors, but this distinction is merely for convenience. An alternating-current dynamo is commonly called an "alternator."

An electric motor is a machine for converting electrical energy into mechanical energy; in other words, *it produces mechanical power when supplied with an electric current.* An electric motor is usually called simply a motor, and although motor might mean anything producing motion, it is very rarely used in any other sense and is perfectly definite in connection with electrical matters.

Principles of Action.—The dynamo is based upon the discovery made by Faraday in 1831, that an electric current is generated in a conductor by moving it in a magnetic field. The electric motor works on the principle that a conductor carrying a current in a magnetic field tends to move. Thus it will be seen from the above statements that the dynamo and motor are exactly the reverse of each other in their action.

Similarity of Dynamos and Motors.—The two machines are, however, very similar in their construction. In fact, the same machine can be used for either purpose equally well. In practice there are sometimes slight differences between dynamos and motors, as will be explained further on, but these are not very important. Hence, as already stated in the introduction, the two machines will be treated as one, except where some distinction is specially stated.

General Form.—We have seen that both the dynamo and motor depend for their action upon the movement of conductors in magnetic fields. Now it has been found as a result of scientific experiment and practical experience during the 60 years since Faraday's discovery, that the best way to carry out this principle is to arrange the conductors in suitable form and rotate them between the poles of a magnet, or magnets. This rotating part is called the *armature* and the magnet is called the *field magnet.* In alternating-current dynamos this plan is sometimes reversed, the field magnets being made to rotate and the armature being fixed.

Armature.—This usually consists of an *armature core* of iron on which are wound or attached the conductors which carry the current. This core should be split up or *laminated*, that is, made of discs, tape or wire, of iron separated by paper, varnish or rust, instead of one solid piece; otherwise it will have useless currents generated in it which would waste the power of the machine. This core is almost always made either in the form of a *drum* or a *ring* and hence we have these as the two principal types of armature.

Field Magnet.—This consists of one or more iron *cores* on which are wound the field *coils.* Attached to the field cores are the *pole-pieces* which form the magnetic field or space in which the armature revolves.

CHAP. II.

DIRECTIONS FOR SELECTING DYNAMOS AND MOTORS.

The choice of a dynamo or motor will, of course, depend largely upon the circumstances in each particular instance. There are, however, certain general facts which apply to almost all cases.

Construction.—This should be of the most solid character and first-class in every respect, including material and workmanship, both of which should be of the best possible quality. All the parts should be of adequate size and strength to ensure durability.

Finish.—What is called a fine finish on a machine is also very desirable, first, because it indicates good construction, and its absence indicates poor construction (there is no essential reason for this, but it seems to be a fact in most cases), and second, it usually causes a machine to receive much better treatment.

Simplicity.—The machine and all its parts should be as simple as possible, and any very peculiar or complicated part or attachment should be avoided. These are sometimes successful but should be well tried and proved before accepting.

Attention.—The amount of attention required by the machine should be small; for example, the brushes should be capable of being easily and securely adjusted, and the oiling devices should be effective and reliable, self-oiling bearings being very desirable. The screws, connections and other small parts should be arranged so that they are not liable to become loose, and the delicate parts should not be particularly exposed or liable to injury. The machine should be made so as to be easily and thoroughly cleaned.

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[1] This chapter has already been published in the Sept., Oct. and Nov., 1891, issues of THE ELECTRICAL ENGINEER, under the title of "The Localization and Remedy of Troubles in Dynamos or Motors."

Handling.—The machine should be provided with rings or other means by which it can be easily lifted or moved without injury. It should be possible to take out the armature conveniently by removing one of the bearings.

Regulation.—Some form of regulator should be provided by which the E. M. F. or current of a dynamo or the speed of a motor can be reliably and accurately governed.

Armature.—This should turn very freely in the bearings, and should be perfectly balanced so as not to have any appreciable jar or vibration at full speed. There should be a uniform clearance of at least $\frac{1}{16}$ inch all around between the armature and pole-pieces. The armature should be capable of moving lengthwise in the bearings at least $\frac{1}{8}$ inch. It is not usually desirable to have the speed of an armature at its circumference more than 3,000 feet per minute. The ring-form of armature is especially suited to high voltage since the coils differing most in potential are at the greatest distance apart. A section of a ring armature can also be more easily rewound than in the case of a drum armature.

Capacity.—This should be ample in all cases. It is a very common mistake to underestimate the work required of a given machine, and, even if the machine has sufficient power at first, the demands upon it are apt to increase and finally overload it. No one is ever likely to regret choosing a dynamo or motor with a considerable margin of capacity, since these machines only consume power in proportion to the work they are doing. For example, a 30 h. p. machine would probably run with a 20 h. p. load more economically and satisfactorily than a 20 h. p. machine with the same load.

Form.—The machine should be symmetrical, well proportioned, compact and solid in form. If it is either very tall or very flat it is usually inconvenient and clumsy. No part of the machine should project excessively, or be awkwardly formed or arranged. The large and heavy portions of the machine should be placed as low as possible to give great stability. For the same reason the shaft should not be high above the base, nor should it be so low that there is not ample room for the pulley or other attachment. A horizontal belt, for example, will sag and strike the floor if the pulley is very low.

Weight.—The common idea that it is desirable to have a very light dynamo or motor is a mistake when it is for stationary use. There is no advantage in a light machine for stationary work, and it has the disadvantages of being less strong, less durable and less steady in running. A sufficient weight to make the machine thoroughly substantial is obviously a great benefit.

Cost.—It is also a mistake to select a cheap machine, since both the materials and workmanship required in a high quality dynamo or motor cost more than in almost any other machine of the same size and weight.

(*To be continued.*)

ONE WAY OF SAVING POWER ON ELECTRIC RAILWAYS.

BY LUCIUS ELLIOT MARPLE.

It is a well-known fact that much of the power generated at the central station of an electric railway is lost in overcoming the resistance offered by poor rail connections. Not only this; but there is consequently a much greater wear and tear on the machinery, and an undue heating of the motors because of the unsteady current resulting. As these are prominent features, it is of no small importance to the railway superintendent that there should always be the best possible connections between the car wheels and the rails.

The following instance, in which the writer was recently called in court to testify, shows that this may be the cause of annoyance in more ways than one:

A car happened to be stalled by dust on the track for a moment, when a "green" horse passing by took fright at it and stumbled, striking his head on the step of the car. It was claimed before the magistrate, and allowed, that a current of electricity from the car had, in some way, caused the animal's death. This decision was appealed from, and happily reversed in a higher court.

Several railways, have, however, overcome this trouble and effected quite a saving by applying water to the tracks in the proper manner.

The simplest and most effective way seems to consist in employing specially made carts, with wheels just fitting between the tracks. On each pair of wheels a large tank is placed six feet or more above the ground. By means of pipes, this delivers a stream of salty water with considerable force directly over either track.

By making several trips daily over each route, the tracks can be kept thoroughly clean and moist. Where this has been tried it has been proved that a very considerable amount of power may be thus saved.

To show the effect of a clean track, the instance may be cited of Nashville, Tenn., where the surface consists very largely of limestone rock. The writer has several times made careful note of the station output before and during a sudden heavy shower.

A reduction of from 900 to 600 amperes, or more than 30 per cent., was actually observed.

Probably the greatest effect will be felt in towns where the streets are unpaved and the travel is heavy enough to keep the rails continually covered with dirt.

THE EXPERIENCE OF CITIES WITH THE TROLLEY SYSTEM.

BY

S. W. Balch

The citizens of Yonkers have recently been discussing at much length the advisability of permitting the trolley system in their city, and the city council have finally decided to permit its use with certain restrictions. In connection with this discussion, one of the enterprising papers of the city, the Yonkers *Daily Herald*, addressed a number of inquiries concerning the trolley to the mayors of 108 cities in which it was understood to be in operation. Replies have thus far been received from 66 cities and towns. Sixty-two show a practical experience with the system and are, therefore, noted in the answers below.

The first question put to the mayors was as follows: "Do you consider that the trolley system has been operated successfully in your city?" All but five answer this in the affirmative. Three report that it is fairly successful, and two say that it has not succeeded.

The second inquires if the fault is believed to be in the system or in the management. From Toledo, O., where the Thomson-Houston and Westinghouse systems are used the answer considers the fault about equally divided. Zanesville, O., reports that good management is everything. Ottawa, Ill., reports that the management is a little lame. Akron, O., and South Bend, Ind., say that the electric cars are not a success on account of the management.

The mayor of Rockford, Ill., considers all overhead wire business bad and hopes that Edison will make a success of his two-track idea. He also remarks that the system is good when well carried out with double motor cars, revolving snow-brushes and heavy rails, and lays the faults to cheap equipment. Camden, N. J., reported that their system was not successful at first because the power generators were not suitable.

The third question inquired whether the system had benefited the business interests of the city. This question is answered affirmatively, and in many instances with emphasis, by all except South Bend, Ind., in which the answer to the question is omitted, and Buffalo, N. Y., where the use has not been sufficient to warrant an opinion. The mayor of Wilmington, Del., reports that the electric cars have infused new life into the people, and that a horse is too good an animal to put to a street car. The city electrician at Springfield, Ill., reports that there is a car every 15 minutes for those who live five miles from the centre of the city and that the great beauty is that the cars are on time.

The fourth question asks, Which system is used? As many cities use more than one system, or combinations of two or more systems it will, therefore, be seen why the numbers here given will sum up more than the number of replies which have been sent in. In 12 replies no answer, or an indefinite answer, is given to the question. From the others it appears that they are in use in, and endorsed as good by, the following places:—

	Used by	Approved by
Thomson-Houston	31	24
Sprague-Edison	24	17
Westinghouse	5	4
Short	3	2
Van Depoele	1	1
Detroit Electrical Works	1	1
Daft	2	0

The fifth question asked the mayors if they consider their system the best. Their replies are incorporated in the above table, but as each appears to be contented with the system which he happens to have, his opinion does not appear to be much of an indication as to which one is the best. In several instances where two systems are used both are endorsed without preference. The mayors of Milwaukee, Quincy, Mass., and Reading, Pa., make no choice between the Thomson-Houston and the Sprague. On the other hand the mayor of Marlboro, Mass., has the latter but prefers the former. The Thomson-Houston system is also especially endorsed by the mayor of Peoria, Ill., and the city electrician of Springfield, Ill. The Sprague and Edison systems are endorsed by the mayor of Canton, O., and the Sprague and Westinghouse systems by the mayor of Wilmington, Del. The mayor of Lancaster, Pa., prefers the Edison to the Daft system.

The sixth question inquired if any persons had been killed by the electric current from the trolley line, and the seventh, how many. These are answered in the negative in every reply but one. This one is from Louisville, Ky., and reports five or six killed by carelessness of passengers. It is not thought from the answer that they were killed by the current. In Canton, O., a little girl was run over. Toledo, O., mentions two injuries. The mayor of Lynn, Mass., mentions accidents to carriages being run into, and Zanesville, O., reports the killing of several dogs. A number report no accident of any kind.

The eighth question asked if accidents from the current were very likely to happen. This was answered unqualifiedly in the negative in 40 of the replies, and no affirmative answer was received. The city electrician of Springfield, Ill., says: "On three occasions I have seen the entire current (480 to 510 volts) pass through a man. Of course he was burned but was at work again in 48 hours. Such cases as these are due wholly to the carelessness of the men while repairing hooks." Streator, Ill., reports that the current has been taken without injury. Johnstown, Pa., answers, "No, the current is not over 500 volts." And Camden, N. J., replies that the voltage is 220 and that fatal accidents are not looked for. The mayor of Milwaukee thinks an accident is possible upon contact with a live wire.

The mayors of several cities referred to their experts for the information sought. Saginaw, Mich., referred to W. J. Hart; Salem, O., to W. H. Wheldey, and Springfield, Ill., answered through Edgar L. Gross, city electrician.

The mayor of Aurora, Ill., sent a very interesting reply, of which the following is an abstract: "We have an elaborate and costly system of street railway propelled by the trolley system, and it operates successfully save when a snowstorm shuts it off short. Nobody has been killed by the electric current, but we have had some narrow escapes from death. Telephone wires are liable to break, and if they fall across the trolley wire it will kindle a fire in the office or residence, a mile away perhaps. One of the trolley wires fell recently in this city and knocked a horse down. If you are about to insert the trolley system, I suggest that you require the company to light the streets which it occupies without charge, placing a lamp on every second or third pole. The city of Providence, R. I., has been considering the granting of a franchise to a street railway company, and I recommend that you send to the Hon. H. Howard of that city for a copy of the pamphlet publication No. 8, of the Advance Club of Providence. It contains the contract which the city of Toronto has with its street railway company, which has many safeguards. The rate of speed should be regulated from time to time by the city authorities, and the company should be held to a rigid accountability for the condition of the street and road-bed which it occupies. A city should prepare its own ordinance granting the franchise, for if prepared by the company they will get the best of you and gain many little advantages by cunningly devised phrases which will hardly be apparent upon casual reading."

The mayor of Allentown, Pa., says that he considers the T rail better than the flange rail in every particular if wagon gauge is not required.

THE LAW OF MOTOR EFFICIENCY.

BY

C. O. Mailloux.

In the issue of The Electrical Engineer of December 16, Mr. H. Ward Leonard attempts to set aside my objections to his so-called law of motor efficiency. I will encroach upon your valuable space once again, not so much for the purpose of further argument with Mr. Leonard, as of straightening out certain questions of fact on which he does not appear to be as well informed as he might be. Mr. Leonard's statements, in fact, tend to strengthen the impression that he has neglected not only the theory but even the history of the "art to which his invention appertains."

It was in 1882 that Marcel Deprez first accomplished what Mr. Leonard now claims as his discovery or invention. He described his method in *La Lumière Electrique* (Oct. 3, 1885, pp. 6, 7). His experimentss have been freely quoted, among others, by Kapp, (Elect. Transm. 3d Ed., p. 89); and also repeated by others, (Thompson Dyn. Elec. Mach., 3d Ed., p. 539).

M. Deprez took a motor which was loaded artificially so as to give a constant moment of resistance, and consequently requiring a constant torque to make it turn. He applied to this motor a source of E. M. F. which he caused to vary from zero up to an extreme limit. He found that for any given load the current increased until it was sufficient to produce the torque needed to start the motor. Any further increase of the E. M. F. caused the speed (and therefore the counter E. M. F. of the motor) to increase so as to prevent the current from rising above the value at which the motor began to turn. He laid down and proved the law that for any load (torque) a certain current is required, and that this current will *automatically* be maintained constant, or very nearly so, at any and all speeds, it being independent of the speed. He also showed that the speed was controlled and governed for a given load, entirely by varying the E. M. F. of the source of supply.

In the original experiment the E. M. F. was regulated partly by varying the speed of the dynamo, and partly by a variable resistance in the circuit. He described later (Oct. 17, '85) a method of varying the E. M. F. of a generator (or motor) run at constant speed, by varying its magnetic field, which is the method of E. M. F. regulation found in Mr. Leonard's method.

Even the plan of separately exciting the motor was first made known and used by Deprez. It requires no extended comparison to see that M. Deprez's method accomplished all that Mr. Leonard's does and by exactly the same means, namely, by varying the E. M. F. of the source of supply. The only difference exists in the details and in the *theory*. Although Mr. Leonard effects his regulation solely by varying the E. M. F. of the source of supply just as M. Deprez did, yet he claims to have some control on the amperes, while M. Deprez made no such claim, but on the contrary recognized and admitted the fact that the amperes do and will control and take care of themselves automatically. The fact that the efficiency is more nearly constant when the E. M. F. is varied with the speed of a motor run at constant torque, has also not escaped attention. The table of tests of a ½ h. p. Immisch motor, quoted by Thompson, (Dynam. Elec. Mach., 3d Ed., p. 562) gives a sufficiently clear indication of it. Every one who has had experience with storage battery cars wherein the speed regulation is effected by grouping or varying the cells, has doubtless observed the fact. The present writer has many records of brake tests made in 1887, and subsequently, which show this very clearly.

In a later portion of his discussion in the same journal, M. Deprez gives (Oct. 24, '85, p. 158) an equation of efficiency which is an extension of that which I gave in my previous article, and which Mr. Leonard may find of interest.

According to M. Deprez, the efficiency depends on three things *only:* 1. The speed of the motor, *i. e.*, the counter E. M. F. 2. The ratio of the total circuit resistance to the motor resistance. 3. The ratio of the watts spent in heating the motor to the torque obtained by the current—which is what he calls the "cost of the torque."

These statements can be made to embrace almost any case of electric power transmission. The conditions and the rule which I gave for obtaining maximum efficiency are in harmony with M. Deprez's views.

So much for the facts as to the novelty of the method or the accuracy of the "law." Let us now see what are the facts in relation to the question of torque in the street car motors commonly used, *i. e.*, in plain series motors.

I quote:—"Mr. Mailloux is, I think, in error in stating that in the street car motors commonly in use the amperes vary as the torque. Such a condition could only be realized in a constant field and with the series field commonly in use, as a constant field is not realized under varying torques, although the commutation of the field is, of course, an endeavor to approximate to it."

The fact is that the amperes vary as the torque in all forms of motors, though not in the same way. In a shunt motor the curve of torque is nearly a straight line; in a series motor it is convex toward the axis of amperes, for the lower values. In both cases, for higher current values the line is either straight or slightly concave to the axis of amperes. The physical or mathematical reasons do not interest us now.

It is sufficient to know that the amperes do vary as the torque in series motors. For medium and high current values the series motor has the great advantage that it requires less amperes per unit of torque than does the shunt motor, and is not so likely to spark, because its load is constant, while that of the shunt motor will change with the current.

I do not regard a constant field as a condition *sine qua non* for accomplishing what Mr. Leonard's method does. A series motor used in place of his separately excited motor would operate quite as satisfactorily in most cases, and more so, in many cases. Mr. Leonard ininsists that when he groups the six motors in different ways, he varies the volts as the speed desired. Until his explanation is made intelligible however, or a more logical one substituted therefor, I must adhere to my previous opinion.

Mr. Leonard has also permitted himself to make the absurd statement that "there is no question that the current *will* be constant for all groupings, neglecting, of course, the slight effect of the losses in heat, etc." No question admits of more easy demonstration. In the abstract, one might ask, if the current is the same for all groupings, then since the direct E. M. F. is also constant, the electrical energy abstracted from the circuit, is constant. Where then would the energy come from which causes the increase of speed? In point of fact it must and does come from increase of current. Let us take a concrete case by assuming that each car requires for keeping it in motion on a given grade that the motors should each develop 200 pound-feet of torque or 1,200 pound-feet for the three cars constituting the train. This torque will, it is evident, be the same, at all speeds usually employed. Hence, each motor must furnish the same torque, no matter at what speed it runs, so long as the load and the grade remain the same. Starting with the six motors in series, a given current, say, 15 amperes is required to produce in each motor the desired torque of 200 pound-feet.

Let us now connect the six motors in two multiple series of three. Each series will again take 15 amperes to give the same torque. The line current will therefore be 30 amperes. If we connect the motors in three multiple series of two, the line current will be 45 amperes; with all the motors in parallel the current will be 90 amperes. The electrical energy supplied to the train, and, in consequence, the speed, will of course increase at each change in grouping. The change of speed will, in most series railway motors, cause a further complication from the fact that the same current will not maintain quite the same useful torque at all speeds, partly owing to changes in the coefficient of friction, and partly to armature reactions. For a given torque the current must be increased slightly as the speed increases. Mr. Leonard's emphatic statement is therefore without foundation. He has apparently confounded this case with one in which the motors remain always connected the same way.

Lastly Mr. Leonard's explanation of my abhorrence of commutators also falls to the ground, in view of the fact that in the method proposed by me the sparking was entirely obviated. There was also no rheostat. The voltage of the dynamo side of the converter was not expected to exceed at any time 25 volts for the function it was to perform. Its output would not exceed 2,000 watts at any time.

As for the question of weight, if Mr. Leonard can really make with 500 pounds of material a motor dynamo, having two distinct fields, of the watt capacity stated in his article, and running at reasonable speeds, and fair efficiency, he has done something that will produce a far greater and more lasting impression than his so-called "law" of efficiency.

RATHITE.

RATHITE is a new insulating compound, composed of vulcanized india-rubber and silk fibre. The idea is to apply this form of insulation in all cases where solidity rather than flexibility is wanted. The compound is due to MM. Waddington, Rath et Cie.

AN ELECTRICIAN'S APPEAL TO PORCELAIN MANUFACTURERS.

The subjoined appeal to porcelain manufacturers is from Mr. Francis W. Jones, the well-known electrical engineer and inventor, and now electrician of the Postal Telegraph-Cable Co., of this city. What Mr. Jones says on the matter of insulators is not only important but true, and it does seem to us that American porcelain manufacturers should have no difficulty in meeting the demand. It should certainly be worth their while, as the insulators used by the Western Union and Postal companies alone must run up into millions, with a steady consumption every year:

To the Porcelain Manufacturers of America:

Up to the present time in this country, glass has been chiefly used for the insulation of telegraph lines. In Europe, however, porcelain is the prevailing material and presents three or four times more resistance to the leakage of current than glass. The great cost of importation under a high tariff, coupled with a lack of knowledge of the advantages gained in Europe by the use of porcelain, are undoubtedly the reasons why glass has been so long adhered to in America, notwithstanding that great loss of business occurs during rains and fogs by the electricity leaking down the poles, rendering the wires inoperative. The insulating properties of porcelain depend on its quality. It requires a good smooth surface, must be perfectly vitrified throughout so as to be homogeneous, impervious to moisture and free from flaws; the glaze must be good. If such an article can be produced in this country, it sooner or later undoubtedly will replace all the glass in use, even should quite a difference in price exist in favor of glass. It would be an advantage if the shape could be made to conform to the present double-petticoat glass, but it may be thought best to adopt the English Post Office pattern. To convince you of the soundness of my views, see F. L. Pope's 1891 edition of "Modern Practice of the Telegraph," page 115. Also Preece & Sivewright's last edition on "Telegraph," page 267. Mr. Preece is electrician of the British postal lines. You will feel convinced, I am sure, that a field is open for your careful consideration and action. I shall be pleased to hear from you further on this (to me) important subject.

F. W. Jones, Electrician.

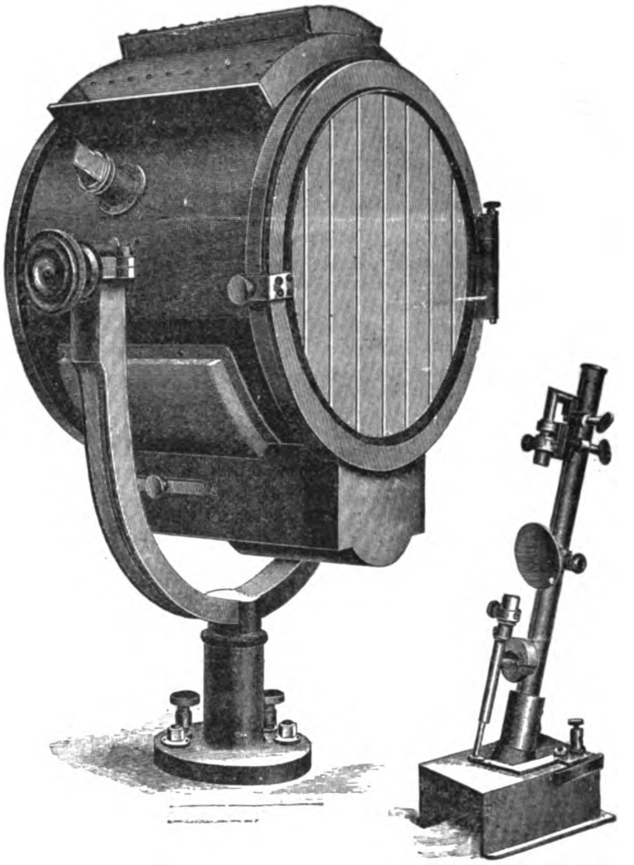
Postal Telegraph-Cable Company,
New York, Jan. 5, 1892.

THE ELECTRIC LAUNCH "ZURICH."

The following particulars from *L'Electricien* with regard to the electric launch, "Zurich," which attracted much attention at the recent Frankfort Exhibition, may be of some interest. The launch was constructed by MM. Escher, Wyss et Cie., of Zurich, and the Oerlikon Maschinenfabrik. The hull was of steel, and the boat was capable of carrying 100 passengers. The dimensions were: Length, 53 ft.; beam, 10¼; mean draught, 3½ ft. The screw, which was 28 in. in diameter, was coupled direct to a 10 h. p. two-pole Brown dynamo run as a motor at 350 revolutions. Power was supplied by a battery of 56 Schoop 31-plate gelatinous accumulators, having a capacity of of 450 ampere hours, and a maximum discharge current of 80 amperes, and weighing in all about 5 tons. The total weight of the electrical equipment was 6½ tons, that of the boat being 15 tons. The motor, when running at 365 revolutions, and absorbing 10 h. p. (102 volts x 75 amperes), propelled the launch at the rate of 8 miles an hour; when only 8 h. p. was absorbed the speed was still 7 miles an hour.

THE THOMSON-HOUSTON SEARCH-LIGHT ON BOARD THE STEAMER "FAIRFAX."

The electric lighting plant on the steamer "Fairfax," described last week in The Electrical Engineer, is, in many respects, a model marine plant. There are 243 16 candle-power lamps in use distributed in the various parts of the ship, those in the three lower decks having water-tight fixtures. The junction boxes, 75 in number, are of bronze, and water-tight, as are also the switches, 10 in number, and the wires are lead-covered waterproof. The lamps are on nine circuits controlled by cut-outs and switches in the dynamo-room, and the mains run to four distributing boxes, conveniently located in different parts of the ship, containing the branch cut-outs and switches.



Thomson-Houston Search Light, with Focusing Lamp.

The search-light or projector, shown in the accompanying illustration, is located on the mast forward of the pilot house, and is equipped with an automatic focusing lamp. The controlling device is placed in the pilot house so that the lamp can be moved vertically and horizontally. The projector takes 20 amperes of current, and is rated at 20,000 candle power.

PROF. AYRTON.

Prof. W. E. Ayrton, F. R. S., president of the Physical Society, at the annual meeting of the Institution of Electrical Engineers was elected to the presidential chair of that body.

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XIII. NEW YORK, JANUARY 13, 1892. No. 193.

The discoveries of great men never leave us; they are immortal; they contain those immortal truths which survive the shock of empires.—Henry Thomas Buckle.

BOODY BARBARISM.

IT has become a fairly well recognized fact that public improvements or the erection of large engineering works must involve, to a greater or less extent, the loss of human life, and indeed in not a few instances this consideration has been made the subject of actual calculation in advance of the undertaking of such works. We might refer to hundreds of instances in which the erection of large structures has been accompanied by loss of life, and we need go no further than to select the Brooklyn Bridge as an instance in point. We have selected this particular example in order to show the fallacy of one of the arguments, if arguments they can be called, which Mayor Boody of Brooklyn has brought forward in connection with his veto of the resolution of the Board of Aldermen granting permission for the introduction of the trolley electric railways in that city. Mayor Boody believes that while "we are called upon to yield many of our present inconveniences for the public good, no citizen in time of peace can be justly asked to hazard life and limb; no amount of material benefit can compensate for the loss of one life!" Would Mayor Boody, we would ask, see Brooklyn isolated from the world because the erection of the Brooklyn Bridge involved a loss of life or because steam boilers on ferry boats have exploded or railroad accidents have occurred? The proposition is so absurd that it needs no further discussion. But we invite Mayor Boody to bring forward a single instance in which human life has been lost due directly to the electric current from an electric railway circuit. Persons have, it is true, been run over by electric cars in the same way as they have been for many years by horse cars and steam railways; but no one dreams of stopping these valuable adjuncts of traffic and returning to the omnibus and stage-coach because people are imprudent enough to cross the tracks upon the approach of trains. Another of Mr. Boody's reasons for vetoing the resolution is that no city of the size of Brooklyn has felt justified in adopting the trolley system. Considering the fact that New York and Chicago have granted trolley privileges within their limits, this part of Mr. Boody's objection is evidently based upon a lack of knowledge; but, aside from that, the reasoning in itself is about as convincing as would be the argument that, because a town of 10,000 inhabitants had adopted a railway trolley system, the method was not adapted to one of 20,000 inhabitants.

Somewhat more than a year ago the *Daily Advertiser*, of Boston, obtained the views expressed by the mayors of a large number of cities where electric railways operated by the trolley system were in operation, and the opinion expressed almost unanimously was, that the community was largely benefited by the increased comfort due to the introduction of the electric railway, and that the advance in the taxable valuation of property was of direct benefit to the taxpayers themselves. Considering that Brooklyn has permitted the erection of many miles of elevated railways, the attitude of its present mayor is hardly consistent, and we are glad to believe that his veto will be overridden by the city council. The more recent opinions of mayors after prolonged operation of electric railways will be found on another page, on which Mr. Balch gives a résumé of the replies received to inquiries emanating from the *Herald*, of Yonkers, N. Y., in which place the subject of electric railways is now being agitated. We are convinced that if the questions involved in the introduction of the trolley system were made a proper subject of study by the mayors and councils of such cities, no difficulty would be encountered in the obtaining of suitable franchises for their introduction.

STORAGE BATTERY WORKING.

IT is about a year since Prof. Ayrton and his associates published a remarkably exhaustive paper on the behavior of the storage battery during charge and discharge, in which special attention was devoted to the examination of the changes which take place in the active material during these stages, a large number of analyses being made to determine the chemical composition at short intervals. In this issue we publish an abstract of an exceedingly interesting paper read by Dr. G. H. Robertson, in which particular attention has been paid to the investigation of the condition of the acid electrolyte and its effects upon the plates during the various stages through which the cell passes in charging and discharging. He recognizes distinctly the great influence of the "active oxygen," hydrogen di-oxide and persulphuric acid, and arrives at the conclusion that for improvements in the cell we must look more to the manner of its handling than to any change in the manufacture of the plates.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.

The large number of works which have appeared during the last ten years treating of the dynamo and motor have done much to make the principles and method of construction of dynamo-electric machinery matters of common knowledge among those interested in the science. But while these books have served an excellent purpose, it cannot be denied that almost without exception they have been wanting in so far as they lacked the details necessary for the practical operation of such machines. By practical operation we mean such a knowledge of the principles of operation as will enable one to select intelligently the machine best suited for his purpose, erect and operate it in the place best adapted for it, and in a manner such as to insure its steady operation under all conditions of use. That such a treatise was needed is evidenced by the fact that several of our large electric companies issue books of instruction intended to supply the information just referred to. But none of these go as deeply into the subject as its importance warrants, and hence we are led to believe that a thorough and systematic treatise on this subject will be welcome at this time. As such we present to our readers the first instalment of the work on "The Practical Management of Dynamos and Motors," by Prof. F. B. Crocker and Dr. S. S. Wheeler. Our publication some time ago of "The Localization and Remedy of Troubles in Dynamos or Motors," by the same talented authors, which may be said to form a part of this work, has given a foretaste of that which is to come; and we thus hope to place before our readers a work which will be of the highest practical value and which will form a fitting addition to the already excellent descriptive works available on the subject of electric machinery.

BLOCK SIGNALS FOR STEAM RAILROADS.

It has taken the public a long time to become fully awakened to the full extent of the parsimonious recklessness and callous indifference to the safety of passengers which has characterized the administration of America's self-styled "greatest railroad," but the past few days have given evidence that the campaign of education is making rapid progress. If anything further were needed to give point to the scathing, if not always intelligent, criticism of the public journals, and to add fresh fuel to the flame of popular indignation, it might have been found in an article which appeared a few days since in an afternoon journal, which, for reasons not necessary to particularize, has generally been regarded as in some sense the mouthpiece of the management of the railroad in question.

This apparently inspired article informs the world that "block signals get out of order continually and lead to delays and collisions. Much better"—the writer says—"is the service of living, faithful flagmen, and *the results have shown how pre-eminently best this system is*. The block system is not worth a cent in comparison." From which profound observation we are made aware that this pretentious ignoramus does not even know what the system is, which he is so swift to condemn. He actually does not know the difference between the block system itself and the special apparatuses which are frequently, though by no means necessarily, employed in operating it. He does not know—or wilfully suppresses the fact—that the "living, faithful flagman" is never dispensed with even under the block system. He asserts that "if the whole system of the Pennsylvania Railroad were to supplant the whole system of the Central, not a train a day would be on time, and accidents would be four times more frequent than now." The all-sufficient answer to this is a comparison of the records. The Pennsylvania, with a much heavier traffic than the Central, has been operated for many years between New York and Philadelphia, under the block system, without the occurrence of a serious collision involving a passenger train, while on the Central, the actual money loss from preventable collisions south of Poughkeepsie during the same length of time, not to speak of passengers slaughtered, has been enough to equip and maintain an efficient block system twice over.

GILBERT, THOMSON, HENRY.

It is with no little pleasure that we begin in this issue a series of articles on the work of Prof. Joseph Henry, by his daughter, Miss Mary A. Henry, who proposes, and gives evidence of her ability, to prove that her distinguished father made an independent discovery of the principle of magneto-electricity. Her charming narrative goes to show not only that Henry, in this, was abreast of the immortal Faraday, but even anticipated him by several months.

Our issue this week contains also a biographical sketch of Sir William Thomson, who has just been raised to the peerage of Great Britain; and since distinction in England takes this form, the honor thus conferred upon one so thoroughly entitled to it will be noted with warm approval by every American electrician and electrical engineer—not omitting Dr. Park Benjamin, who would prefer to see the recognition take some other shape than the award of an empty title. The description given by Mr. Shaw of his visit to the great and modest Scotch philosopher is full of interest and not less so because it is timely.

But we do feel that there is some warrant for the indignant outburst of Dr. Benjamin, in our columns this week, as to the neglect shown to the memory of William Gilbert, who was at once the Henry and Faraday of his remote times, and who enjoyed consideration while alive at least equal to that which we all have long delighted to pay to Sir William, now Lord, Thomson. Why is Gilbert allowed to fall into such oblivion, or if he be remembered, why are not the memorials of his life and work preserved with as much reverence as after ages will evince for the mementos of Henry and Faraday and Thomson? We will not find fault with our English friends in this matter, for our own pages this week show that it has become a duty to vindicate the memory of Henry; but it is at least safe to say that if they do not soon take the matter up it is one that American electricians will feel constrained to be active about.

WIPING OUT THE MEMORY OF GILBERT.

BY

Park Benjamin

It seems to me that it is about time to organize in this country a "Gilbert Society" for the purpose of preventing the wiping out of the memory of William Gilbert. That task was begun by Francis Bacon probably in Gilbert's lifetime, and repeated attempts in the same direction since then have not been wanting; as witness the stupid article concerning him in the ninth edition of the Encyclopædia Britannica. I suppose that such a magnificent tribute as was paid to Gilbert by Galileo would be sufficient to keep any man's memory green even during the 17th and 18th centuries; but towards the end of the latter period despite the praises of the great Italian, some one found it necessary to make a new and peculiarly insidious attack upon Gilbert; and this I happened to unearth the other day in a rather curious way.

Pretty much everybody who has written a biographical sketch of Gilbert within the last dozen or so years has alluded to his portrait as existing in the Bodleian Library at Oxford. It is well known that that portrait was painted at the order of Gilbert himself; that it represents him in about his 48th year, and depicts him in his doctor's robes standing with his hand on the "terrella," which was his artificial earth made out of a piece of loadstone. Upon the picture and above the figure there was inscribed, first, the word "*Terrella*," then the date "1591; *ætatis* 48," and also in the background and a little below his left shoulder were the words: "*Magneticarum virtutum, primus indagator Gilbertus.*"

A couple of years ago there came into my possession an old print purporting to represent William Gilbert, and tallying in all respects with the description of the ancient portrait except in the following very significant details: The inscriptions were totally absent, and for the terrella had been substituted an ordinary terrestrial globe with the usual signs on it. As it struck me that these omissions were certainly very remarkable, and quite in line with previous efforts to slaughter Gilbert's reputation, I took occasion last September when in England, to go to Oxford for the express purpose of seeing the picture, and if possible of having a photograph made from it. I found in the Oxford stationers' stores abundant photographs of every one of the other historical portraits in the famous library, but none of Gilbert; and so I addressed a courteous request to the librarian asking permission to make the photograph in question. That gentleman in reply asked me to call upon him, which I did, and once more proffered my request, expressing at the same time the great interest which all American electricians felt in the fame and reputation of William Gilbert. He heard me through patiently, and then with a half smile, remarked:

"Well, I should be very glad indeed to allow you to photograph the picture but for one reason, which I fear must be controlling."

"And that is"—I asked.

"There isn't any picture."

As this was rather staggering in view of the repeated statements by British writers living within a hundred miles of Oxford, including various professors, I ventured to suggest that perhaps the librarian was mistaken, or was confusing the portrait in question with some one of the many others hanging in the gallery. He smiled superior once more and proposed that I walk through the room and see if I could find that portrait, which, perhaps with more zeal than politeness, I did. Then I came back to him and asked:

"Well, where is it?

"Seeing that it was removed," he answered, "over a hundred years ago, I do not know."

"Who removed it?"

"I do not know."

"Why was it removed?"

"It got decayed. It was on board, and the board rotted."

"Might I ask the source of your information?"

"Certainly," he said.

And thereupon he went to the shelves of the library and brought me a copy of the "Histories and Antiquities of the University of Oxford" by Anthony A. Wood, dated 1796, opened it at page 96 of Vol. 2, and there appeared a brief paragraph describing the picture as I have described it above, terminating with the laconic statement "Decayed and removed."

"Is there no record," I asked, "that it was ever returned?"

"None."

"Is there any receipt in the archives from anybody who took it away?"

"None."

"Has any other picture been removed from this famous collection?"

"None that I know of or have any record of."

"It is a fact, isn't it, that there are a great many pictures here of far earlier date than that of Gilbert?"

"Certainly."

"Judging by the looks of those pictures, a number of them have been restored?"

He assented.

"Well, don't you think it is remarkable that such a thing could have happened in the most conservative institution in the most conservative town in the most conservative nation in the world?"

"Very."

Then I asked him if he knew of any picture of Gilbert, and he very obligingly went to the Department of Engravings and Prints and brought me a copy which he said was of a very rare publication, but which turned out to be the same print that I had myself.

Now, it is rather a singular coincidence that the date on this print, 1796, is the same date that is on Wood's book. The print was made by a London engraver. If he did not make it from the old portrait, what did he make it from? If he did make it from the old portrait, why did he carefully leave out of his copy every word and everything which could do credit to Gilbert as the great discoverer that he was? Who allowed Gilbert's portrait to be taken from the Bodleian Library without a word of record being left behind? How did its board come to be decayed when other panel pictures did not so become? And even if it had become decayed, what was to prevent the film of paint being taken from the surface of that board, as has been done in hundreds of instances in restoring the oil paintings of the old masters, almost invariably done on panel, and remounted centuries later on canvas after their original boards had almost fallen to dust?

Gilbert, when that portrait was painted, was at the zenith of his fame as a physician. He rose to higher eminence ten years later when his book appeared. He was a graduate of Cambridge, and therefore Oxford did not hang up his portrait merely as one of its alumni, but as that of a man whom it honored itself by honoring. It cannot be said therefore that his portrait represented some one of no importance, for even when it was stolen, Gilbert's reputation was ineffably above that of dozens of the noble nincompoops and nobodies who still smirk down from those venerable walls.

So much for the past. Some time ago there was organized in England a so-called "Gilbert Society," which, we were told, was very solicitous for the fame and reputation of the discoverer. In the announcement of its establishment there appeared a long list of eminent scientists as members headed by that of the distinguished philosopher recently degraded to the English peerage. This concern was going to translate Gilbert in the highest style of the art. It has, I believe, taken subscriptions on this side of the Atlantic for its forthcoming translation. It was going to conserve and promote the memory of Gilbert. I made some inquiries while in London recently, about that society and its work, but gleaned little information. In fact, it was not easy to demonstrate its existence, although, subsequently, I was informed that it still lived, but that the preparation of its translation of Gilbert's book was not being very actively pushed; a statement that made me regret that on learning of the superior ability to be devoted to the matter abroad I had laid down the pen with my own translation of the work half finished.

Meanwhile, still pursuing my quest, it occurred to me that if I could not get a photograph of a picture of Gilbert, perhaps I might get one of his tomb; and so I sent over to a friend in London asking him if that could be done. The tomb is in the parish church in Colchester. His reply, just received, after pointing out some difficulties (the monument is high up on the church walls, there is a deficiency of light in the interior, and it will perhaps be troublesome to arrange a camera) sets forth what I suppose is the most recent attempt to blot out the memory of Gilbert; and it is a little startling. "Gilbert's memorial," writes my correspondent, "narrowly escaped destruction some time ago, when the church was in process of restoration; but our friend, Mr. Laver, a scientific man, who was then one of the church wardens, fortunately happened to see one of the workmen *wheeling the monument off in a barrow* and rescued it from demolition."

As I said in the beginning of this communication, it seems to me high time that some action, in this country, should be taken to protect the memory of William Gilbert from British depredations. *Quis custodiet custodes?*

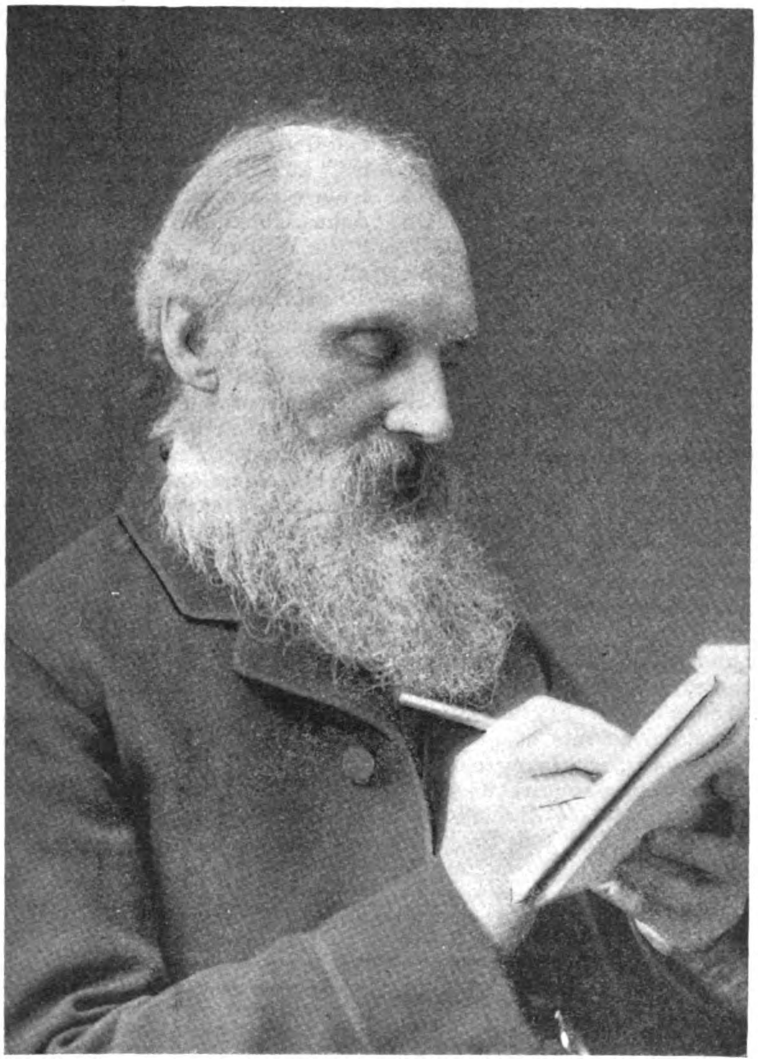
M. C. L. Weber, in an article recently published, gives the details of construction advocated for a small battery of accumulators. Two coils of lead wire, one above the other in long, thin glass tubes, is the arrangement shown. Such batteries would be used for laboratories or to charge electrometers.

WITH SIR WILLIAM THOMSON IN GLASGOW.

BY

A. C. Shaw.

The Atlantic cable has just brought to us the gratifying news that Sir William Thomson, the world-renowned electrician, has been raised to the peerage of England, and will hereafter be known to the world as Lord Thomson. Only a month or two ago Sir William was the recipient of high honor at the hands of his fellow-citizens of Glasgow, who, to commemorate the occasion of his election as president of the Royal Society, presented him with his portrait painted by the famous artist Herkomer, through the Right Honorable A. J. Balfour, then on a visit to Glasgow. At that time I had the good fortune to be sojourning in Glasgow, and had the pleasure of calling on Sir William first at his home in the University Yard, and afterwards at his laboratory, whence have come so many of those wonderful electrical instruments, which have served to win for him a world-wide reputation as the most eminent English electrician of the day, and have made his name a household word not only with scientific men, but among the people at large. Who, for instance, has not heard of the Thomson reflecting galvanometer and siphon recorder for cabling, or the sounding machine, enabling investigators to get accurate ideas of the nature of the ocean bed, or the Thomson mariner's compass, that wonderful instrument which seems to correct all errors in compass readings, and enables the mariner of to-day to make the trip from New York to Liverpool with as much accuracy as if the ship were guided on steel rails from one city to the other?



William Thomson
Glasgow Nov 28/91

It was, therefore, with feelings of profound gratification that I took the opportunity of a visit to Glasgow to call on Sir William and procure data regarding his life's history, which I now take pleasure in presenting to your readers, along with his portrait, which I may say, in passing, is an excellent likeness, and one which finds favor in Sir William's own eyes. As has been previously said, Sir William received me in his own home, in the University Yard, tendering me a hearty welcome and true Scotch hospitality. Being naturally interested in everything electrical, he then plied me with questions as to the *modus operandi* of the various systems of electric light and power in this country, being particularly interested in the wonderful and rapid development of electric street railway work. Practically there had been (with the exception of Leeds) almost no work of this kind in England, especially with the overhead trolley, and many were the pertinent questions asked as to the success and efficiency of such a system. Taking Boston for a text, and the West End Street Railway Company as an example, I assured Sir William that Americans had heartily endorsed the overhead system, and had found that electric railways were actually a necessity to the success of any enterprising city in the United States, and that though there had been severe opposition at first, the overhead wires were conceded to be much less of a necessary evil than the old antiquated horse cars. It may interest readers of THE ELECTRICAL ENGINEER to know that the city of Glasgow is at present considering seriously the question of adopting electricity as a motive power on its street railways, so that the subject was doubly interesting to Sir William at that time. On arriving at the laboratory I was presented to Dr. J. T. Bottomley, who has for so many years ably assisted Sir William, and who is himself well known to all electricians as the author of many familiar and valuable works. With Dr. Bottomley's assistance, I made a careful examination of many of the most recent inventions of Sir William, paying particular attention to his new standard electrical instruments for accurately measuring potential and current either in very small or very large quantities, and which are made by Mr. James White, of Glasgow, who has built all the Thomson instruments for the past thirty years. The most notable of these instruments are the standard direct-reading ampere balances, instruments founded on the mutual forces, discovered by Ampere, between movable and fixed portions of an electric circuit. These instruments are totally different from any other instruments in the market, and are absolutely accurate. Even more interesting than these, however, are the Thomson electrostatic voltmeters, which have the great advantage of being available as accurate measurers of potential on both direct and alternating circuits, and being electrostatic, use no current, and consequently require no temperature correction. These instruments are divided into three classes, the multicellular, the vertical and the electrostatic balance, and have a range of from 40 to 100,000 volts. It is needless to say that there were many other interesting and novel instruments to see, notably the latest invention, the Thomson wattmeter, and a variety of very large ampere-meters capable of measuring up to 100,000 amperes, without in any way heating—but I must hasten on to a short résumé of Sir William's life.

Sir William is an Irishman, by birth, though of Scotch descent, having been born in Belfast, in June, 1824. His father was educated at Glasgow University and afterwards became professor of mathematics in that college. Sir William, with his brother, James (now professor of civil engineering in Glasgow University) early took honors at the college, afterwards going up to Cambridge, where he graduated as second wrangler, in 1845, and first Smith's prizeman. At this early stage he was already noted for his success in mathematics, although other sciences had also great attraction for him, and at the same time he found leisure to devote himself to literature, music and even athletics. About this time he became interested in the study of magnetism and electricity, and gave birth to entirely new ideas on the subject of electric "potential," a subject at that time very imperfectly understood. In 1846, Thomson was elected professor of natural philosophy, in the University of Glasgow, which position he fills to-day with so much honor, having refused most tempting offers to go to English universities. In 1855 and 1856 he first gave his attention to ocean telegraphy and supplied the 1858 cable with the mirror-reflecting galvanometer, which first allowed the ocean cables to be successfully used commercially, and overcame the great difficulty of retardation. This was the first of the instruments which Sir William patented, much against his wishes, at the instigation of the Atlantic Company, as he was ready to give the public freely the fruit of his labors. Then followed the Thomson siphon recorder which was invented in 1867. This was generally brought into use three years later, and is the standard ocean cable instrument of to-day. The sounding machine and his mariner's compass were perfected about the years 1875 and 1876, and are both so well known that it is unnecessary to say anything about them. It is impossible to enumerate in this short sketch the many important points in Sir William's history, or the many useful instruments he has given to scientists, but it is interesting to note that he was in Philadelphia, in 1876, at the International Exhibition, and again in 1884 visited this country and delivered a course of lectures "On Molecular Dynamics," at Baltimore, to a class composed mainly of professors from various parts of the world, gathered together at the Johns Hopkins University.

Sir William has had honors presented to him from nearly all the universities of Europe. He is now president of the Royal Society, and ex-president of the Royal Society of Edinburgh, member of the Institut de France, the Academia dei Lincei at Rome, the Berlin Academy, the Amsterdam Koninklije Akademie and the American Academy of Sciences. He has attained almost every honor that scientific bodies can bestow on him, and, as has been already stated, has recently been recognized by the Queen by his elevation to the peerage. And yet with it all, what a modest, true-hearted, kind, genial man is there! A man whom it is an honor to meet, and yet who greets every one with a hearty frankness which at once dispels all sense of intrusion, and who inspires feelings of confidence, respect and love. Sir William, though now in his sixty-seventh year, is still as active as ever, intensely interested in all scientific work, beloved by his students, and honored by his fellow-citizens; and it is my sincere hope that he may yet be long spared to his sphere of usefulness, and the pursuit of these studies, which have yielded so much valuable fruit in the past, and which can form an ever-fruitful field of research to such penetrating genius as he so richly possesses.

SECONDARY BATTERIES.

MR. G. H. ROBERTSON'S paper, read recently before the London Society of Arts, brought out several interesting points relating to the chemistry of secondary batteries, or more particularly the chemistry of the acid, which are worth the careful study of those engaged in this specialty of electrical science. Referring to experiments with electrolytes, he says:

> Although so many different modes of manufacture and preliminary treatment have been resorted to, all the batteries, so far as I am aware, which depend for their action on the couple formed between lead and lead peroxide in dilute sulphuric acid, exhibit the characteristic peculiarities noticed by Planté in his cell, namely: The high initial E. M. F. of a freshly-charged cell; the fall of E. M. F. on breaking the charging circuit, with corresponding rise on breaking the discharging circuit; the very rapid fall towards the end of discharge which occurs earlier, the more rapid the discharge is, and is not due to the exhaustion of the active material, as, after a rest, a fresh discharge can be obtained.
>
> As the defects, namely, sulphating and buckling, which have retarded the introduction of reversible lead batteries, are also common to the two types, it appeared possible that they were due to the same causes which produced the variations in E. M. F.; therefore, as the work of Dr. Oliver Lodge[1] in 1883, and of Miesler[2] in 1888, had shown that the causes of the variation must be sought either on the lead plate or in the acid next it, and the chemistry of the plates afforded no explanation,[3] I last year, with Dr. Armstrong's advice and assistance, undertook the investigations of the reactions occurring in the acid.

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[1] Cantor lecture.

[2] "Monatshafte für Chemie," viii, 713.

[3] For references and a summary of the principal work done on the cell, see the London *Electrician*, Vol. xxvii., No. 682, p. 165; No. 692, p. 437.

In 1878 Berthelot[4] discovered persulphuric acid ($H_2 S_2 O_8$), and brought forward evidence to prove that it is the primary product of the electrolysis of sulphuric acid solutions, and that the hydrogen dioxide—which, from Faraday's time, has been well known to be present in sulphuric acid after electrolysis—is really due to the action of this body on the acid. The products of electrolysis vary with the strength of the acid, 40 per cent. acid (density 1.300) yielding practically no hydrogen dioxide; while below and above that strength it is present in varying proportions. High current density and an electro-negative condition of the electrodes favor their formation.[5] Persulphuric acid is an unstable body, and begins to decompose as soon as the current which has given rise to it is stopped, and its decomposition is accompanied by the formation of hydrogen dioxide, unless the sulphuric acid is too dilute. Hydrogen dioxide is also unstable when concentrated, but a weak sulphuric acid solution of it is comparatively stable, and the stability increases the less hydrogen dioxide it contains; therefore this body is found in estimable quantities long after the persulphuric acid which gave rise to it has disappeared. Persulphuric acid is at once decomposed by spongy metal, such as platinum black, by heat with evolution of oxygen,[6] and resembles hydrogen dioxide in these reactions, and in releasing iodine from potassium iodide, but, unlike it, has no action on permanganate of potassium or peroxide of lead. The effect of electrolyzing a sulphuric acid solution of hydrogen dioxide is simply to increase the rate of the decomposition occurring spontaneously, if a weak E. M. F. is used[7]; but on increasing the E. M. F., though the rate of decomposition is increased, a little persulphuric acid is reformed. Subsequent workers have in the main confirmed Berthelot's conclusions. To the oxidizing oxygen in the products of the electrolysis of sulphuric acid, Berthelot gave the name of "active oxygen," and as they pass one into the other, and for most purposes connected with a battery it is not necessary to discriminate between them, I have retained it.

EXPERIMENTS AT THE GENERAL POST OFFICE.

That the nature of the electrolyte affected the behavior of the cell, was evident from information received from Mr. Barber-Starkey with respect to the effect of the addition of sodium carbonate, and it seemed possible that the different behavior of cells containing this substance was due to its catalytic action on hydrogen dioxide, which is known to be exceedingly unstable in the presence of a trace of alkali; and hence a comparative study of the reactions occurring in cells containing ordinary dilute sulphuric acid, and in those which had been treated on Mr. Barber-Starkey's plan seemed likely to elucidate the causes of the sulphating during rest, and the high initial E. M. F.—the two features most affected by this treatment.

Mr. Preece most kindly aided the investigation by allowing experiments to be carried out at the General Post Office, where one-half of the secondary cells contain 1 per cent. of sodium sulphate, and the other half ordinary dilute acid, density 1.180. He also put at my disposal the records of the behavior of the cells, and they proved that there was much less sulphating with sodium sulphate, as shown by the density of the acid never falling to the same extent as in the plain cells. The following readings, taken from short-circuited cells with badly broken plates, illustrate this. In two cells containing ordinary dilute acid, the density of the electrolyte had fallen to 1.100, while, according to the last readings before the short circuit occurred, it had been 1.170 and 1.180 respectively; while in two sodium sulphate cells the density had only fallen to 1.180 from 1.200 under similar circumstances. This was strong evidence in favor of the hydrogen dioxide formed in the working of the cell being appreciable in quantity, since if sulphating were only due to local action between the support and the paste, there does not appear any reason why the addition of sodium sulphate should affect it.

Whenever the cells were tested they were always found to contain "active oxygen," which was due to the presence of persulphuric acid and peroxide of hydrogen in varying proportions. During charge, persulphuric acid is the main constituent; during discharge the quantity of hydrogen dioxide gradually increases, while in a cell which has been at rest some time, there is very little except hydrogen dioxide to be found.

In addition to the tests made on the cells in the electric light and telegraph batteries, I studied the formation of the "active oxygen" during charge and discharge on some cells which were kindly set apart for my special use. The "active oxygen" forms at once on the passage of the current, decreases slightly, and then increases to a little above its first value. Starting either charge or discharge always causes an initial increase, except in the case of cells which have been long idle, when there is a diminution, due to the decomposition of the excess of hydrogen dioxide in the acid.

To test whether electrolyzed acid was able to reduce pure peroxide of lead, two equal lots of peroxide were taken by weighing one against the other, and put in two flasks. One to each, 100 cc. of acid, from next the positive plate of a cell at full charge, was poured, and this caused the evolution of oxygen, which continued slowly for some days. At the end of a fortnight the amount of peroxide of lead in each sample was estimated, and it was found to have decreased from 97.4 per cent. to 93.94 and 94.04 per cent. respectively. This appears to explain the well-known deleterious effect of rest on a cell, for although persulphuric acid itself does not reduce peroxide of lead, it forms hydrogen dioxide on standing, which is capable either of oxidizing the lead plate to litharge or of reducing the peroxide plate to the same substance. In each case the litharge is converted into sulphate by the sulphuric acid. In an ordinary cell in good order the amount of "active oxygen" is small, varying in quantity from about 0.01 grm. to 0.02 grm. per litre; but this means that in a 45-pint cell (the size used at the Post Office) there was always sufficient to convert from 3.25 grms. to 7.5 grms. of peroxide of lead into sulphate, or to undo the work of one to two ampere-hours' charge. The figures just given do not represent the total amount of "active oxygen," since the acid absorbed by the plates cannot be tested; but as the acid has more oxidizing power, the nearer you get to whichever is the positive plate, except at the commencement of discharge, and the total quantity of "active oxygen" increases rapidly soon after breaking circuit, it seems fair to assume that this increase is due to diffusion from the plates of acid which has more oxidizing power than that in the body of cell. This increase is followed by a decrease which is rapid at first, and then gradually gets very slow, and practically ceases while there is still a fair proportion of "active oxygen" left in the cell.

In the sodium sulphate cells the amount of the oxidizing agent was usually less than in the plain cells; and the amount of hydrogen dioxide was always so, unless the battery had been at rest for some time, when the conditions were occasionally found to be reversed. This, I suppose, is due to the proportion of "active oxygen" in the form of hydrogen dioxide, at the moment of stopping the current, being greater in the plain than in the sodium sulphate cells, while the latter contain more persulphuric acid. In both cells the hydrogen dioxide present at the time of stopping the current will be reduced on the plates, sulphating the surface, and more or less screening them from further action; but, as the sodium sulphate cell contains more persulphuric acid, the subsequent formation of hydrogen dioxide will be greater in it than in the plain cell. As far as I could discover, sodium sulphate has little or no action on the acid unless it is added during electrolysis, or to acid which has just been taken from a cell through which a current is passing.

The Effects of Hydrogen Dioxide on the E. M. F. *of a Cell.*—The presence of hydrogen dioxide having been thus proved, both directly and indirectly, its effect on the E. M. F. of the cell was tested. This was done by using strips of lead packed tight into small porous pots, with peroxide of lead to represent the peroxide plates, and using plain strips as the lead plates. A solution of pure sulphuric acid, density 1.180, was used as the electrolyte. The E. M. F. of the couple was taken by the deflection method, and then a drop or two of hydrogen dioxide was added to the acid, which produced a great diminution, or even reversal, of the E. M. F. The effect of introducing hydrogen dioxide into the body of the peroxide paste was also tried with a view of reproducing, if possible, the conditions of a cell which is started discharging directly the charge is completed, and in which the "active oxygen" would be accumulated at the positive plate, leaving the lead plate free, and I found that there was a slight increase in E. M. F.

Thus the variations in E. M. F. appear to depend on which plate hydrogen dioxide is formed at. When present at the peroxide plate it causes a rise, but when diffused through the acid and present at the lead plate it causes a lowering of the E. M. F.; and the rise in E. M. F., sometimes noticed on starting the discharge of a cell which has been at rest (mentioned in Prof. Ayrton's paper, J. I. E. E., 1890, p. 572), is probably due to the electrolysis and decomposition of hydrogen dioxide, for, in a cell which has been long idle, practically the whole of the "active oxygen" is due to this body.

CONCLUSIONS.

From the same faults appearing in batteries of such different construction, and judging also from the results of the experiments recorded in this paper, it would appear that the troubles occurring in batteries are due rather to causes arising in the working than in the manufacture. What is required is some substance which can be added to the acid to check the formation of the oxidized bodies in it, which cause sulphating, without at the same time injuring the plates in other ways. Nearly all the "forming" baths which have been introduced are baths in which hydrogen dioxide would be broken up as soon as formed, and, perhaps, in some modification of them the electrolyte of the future will be found; though, since the products of the electrolysis of sulphuric acid vary with the strength of the acid and the current density, no hard and fast rule can be laid down for the treatment of cells.

In cells containing acid below density 1.200, in which the proportion of "active oxygen" existing as hydrogen dioxide is high, the addition of one per cent. of sodium sulphate, or similar substance, is likely to prove beneficial, particularly if the work of the cells is intermittent. As the strength of the acid is increased, however, and the conditions are more favorable to the stability of persulphuric acid, less hydrogen dioxide will be produced, and there is more chance of the alkali released from the sodium sulphate during electrolysis damaging the plates.

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[4] Berthelot. (*Compt. Rend.*, 90, 269–275.)

[5] Richarz. (*Ann. Phys. Chem.* [2] 31, 912.

[6] Berthelot. (*Bull. Soc. Chim.* [2], 34, 78–81.)

[7] Berthelot. (*Compt. Rend.*, 86, 8–11.)

Also, Dr. Marshall has succeeded in preparing pure persulphuric acid, and has shown this year that it forms salts with the alkalies which are very stable; and what the effect on a cell of the formation of of sodium persulphate in it would be, is quite unknown. Although the formation of peroxides in the acid does not apparently account for the great gasing and sudden loss of charge sometimes observed, still we have seen that makers are reverting to Planté's process of manufacture, or modifications of it, and we may find that in this case also he was right, and that it is to the electrolyte we must look if we wish to find the means of materially improving the lead reversible battery.

LONG-DISTANCE TRANSMISSION OF POWER BY ELECTRICITY.[1]

BY FRANCIS R. HART.

GIVEN a point were power is best obtainable and another point where such power can be most advantageously used, the problem given to the engineer for solution is that of transmitting this power from the one point to the other. If the transmitting agent is electricity, the method is called one of *electrical power transmission.*

There are two general types of electrical methods that can be employed, (1) haulage, and (2) line transmission.

The first is comparable to the haulage of coal from the mine to a distant factory, there to have its stored energy utilized in mechanical work. The skeleton of such an electrical power-transmission system is shown in the following diagram:

TABLE I.

SOURCE OF POWER, { Fuel. / Water. / Wind.
|
ENGINE, { Steam-engine. / Water-engine. / Wind-engine.
|
MECHANICAL-ELECTRICAL TRANSFORMERS, (Dynamos).
|
STORAGE DEVICE, (Storage batteries).
|
HAULAGE SYSTEM, { Carts. / Tramway. / Boats.
|
ELECTRO MECHANICAL TRANSFORMERS, (Motors).
|
MACHINERY TO BE DRIVEN.

More anologous than the haulage of coal to this method would be a compressed-air system. If the steam-engine or turbine at the source of power drove air compressors which filled portable vessels with compressed air, and these vessels were transported and attached to air engines at a distant point, we have a system directly comparable with the electrical haulage plant.

The storage battery street car is an example of this method of electrical power transmission.

The other general type of electrical methods for distant delivery of power employs a line of conducting wires between dynamo and motor in place of the cumbersome system of haulage.

The second system has obvious advantages for long-distance transmission and I shall consider with you that only. There are conditions, however, where even for other than tramway work the haulage system may be the only or best system that can be employed.

I have given *fuel*, *water* and *wind* as the three power sources which may be employed to drive a power system. Some of the uses to which electrical methods of transmitting power may be put are shown in the following table:

Steam:
1. Large number small users obtain more economical power from one engine.
2. Local distribution from lighting companies.
3. Street railways.
4. To replace long shafts.
5. Special works (mines, etc.).

Water:
1. Locate mill with reference to shipping conveniences.
2. Concentration of small water-powers.
3. Carrying power into cities for factories, street railways, etc.
4. Continuous use of power (power during day and lighting at night).

Wind:
1. Pumping (mines and irrigation); wind-engine at best point and pump anywhere.
2. Lighting with storage cells.

The skeleton of the system is as follows:

SOURCE OF POWER. { Fuel. / Water. / Wind.
|
ENGINE, { Steam-engine. / Water-engine. / Wind-engine.
|
MECHANICAL-ELECTRICAL TRANSFORMERS, (Dynamos).
|
CONDUCTING WIRES.
|
ELECTRO-MECHANICAL TRANSFORMERS, (Motors).
|
MACHINERY TO BE DRIVEN.

In practice, except for street railway and mining work, fuel is not an economical source of power for long-distance transmission plants. Ordinarily it is cheaper to deliver the coal at the distant point and obtain the power directly. In connection, however, with water-power the usefulness of an electrical power system can hardly be exaggerated.

Before describing to you the various systems that can be employed for line electrical power transmission I wish to call your attention to certain points concerning the efficiency of such a method and how far we can govern this efficiency. We call the mechanical efficiency of a system the ratio of the power delivered to the dynamo-electric machines at one end of the line to the power delivered by the electric motors at the distant end.

The commercial efficiency of a dynamo or motor, as I shall show you later, varies with its load. The maximum efficiency of good machines should not be under 90 per cent. and is seldom above 92 per cent. Under the most favorable conditions, then, we must expect a loss of, say, 9 per cent. in the dynamo and 9 per cent. in the motor.

The loss in transmission, due to fall in electrical pressure or "drop" in the line, is governed by the size of the wires, the other conditions remaining the same.

For a long-distance transmission plant this will vary from 5 per cent. upwards.

With a loss of 5 per cent. in the line the total efficiency of transmission will be slightly under 79 per cent.

With a loss of 10 per cent. in the line the efficiency would be slightly under 75 per cent. We may call 80 per cent. the practical limit of the efficiency with the apparatus of to-day.

The methods for long-distance power transmission by electricity may be divided into three general classes: (1) Those using continuous current; (2) those using alternating current; and (3) regenerating or "motor-dynamo" systems.

I have tabulated the subdivisions of each of these general classes as follows:

- Continuous current.
  - 2-wire.
    - Low voltage.
      - One machine.
      - Machines in parallel.
    - High voltage.
      - One machine.
      - Machines in parallel.
      - Machines in series.
  - 3-wire
    - 2 machines in series.
    - Machines in multiple-series.
  - Multiple-wire
    - Machines in series.
- Alternating current.
  - Alternating single phase.
    - Without conversions (1).
    - With conversions (2).
  - Alternating multi-phase.
    - Without conversions.
    - With conversions.

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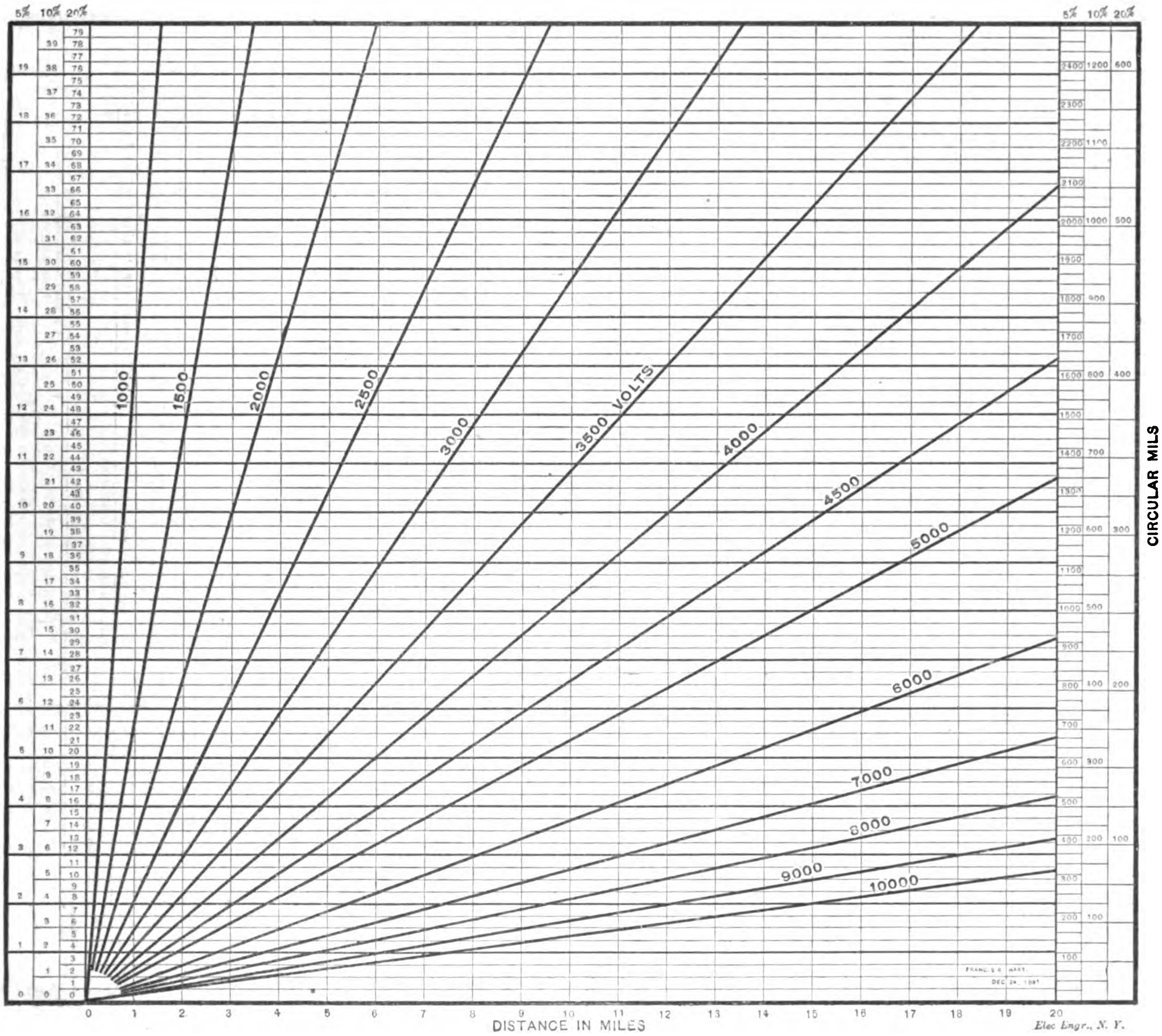
[1] A paper read before the Society of Arts, Boston, December 29, 1891.

Regenerating systems.	Alternating-continuous.
	Alternating converter; line converter; alternating-continuous.
	Continuous-continuous.
	Partial reconversion of any system.

The relative advantages of these systems vary with each particular transmission problem, but in a general way may be tabulated as follows:

The system selected must (1) fill construction and operation conditions, and (2) give minimum cost per horse-power delivered. There are many factors which govern the selection of a system. For each problem considered there will be found certain fixed and certain unfixed conditions.

In general the fixed factors are as shown in Table II.



Elec. Engr., N. Y.

FIG. 1.

1. Capacity of source of power; 2. Cost of power at source; 3. Cost of power by other means at point of delivery; 4. Danger considerations at motors; 5. Operation conditions; 6. Construction conditions, (length of line, character of country, etc.)

The partly fixed conditions are:

7. Power which must be delivered (*i. e.*, the efficiency of the system). 8. Size and number of delivery units.

The variable conditions are:

9. Initial voltage; 10. Pounds of copper on line; 11. Original cost of all apparatus and construction; 12. Expenses, operating: (Fixed charges, interest, depreciation, taxes, insurance, etc.) 13. Liability of trouble and stoppages; 14. Danger at station and on line; 15. Convenience in operating, making changes, extensions, etc.

Assuming that the cost of dynamos, motors, etc., will be approximately the same whatever the initial pressure, I shall show you the great variation in the cost of wire at different pressures. For convenience in working out such problems for rapid and approximate determinations, I have drawn a diagram on chart, Fig. 1, from which can be determined the pounds of copper required for transmitting any number of horse-power from one to twenty miles with an initial pressure of from 1,000 to 10,000 volts, at various losses in transmission. The scale of ordinates on the left gives the total pounds of copper required for one horse-power for each mile transmitted at 5 per cent., 10 per cent. and 20 per cent. loss in transmission. The scale of ordinates on the right gives the area in circular-mils of one of the two necessary wires at the same percentage losses.

To illustrate the use of the diagram, suppose we wish to know the weights of copper required for transmitting 100 h. p. 5 miles at 2,000, 3,000, and 10,000 volts and at 10 per cent. and 20 per cent. loss respectively. By inspection of the diagram we obtain the following figures.

Voltage.	Drop.	Total Pounds Copper.
2,000	10 per cent	33.6 × 100 × 5 = 16,800
	20 per cent.	16.8 × 100 × 5 = 8,400
3,000	10 per cent.	14.8 × 100 × 5 = 7,400
	20 per cent.	7.4 × 100 × 5 = 3,700
10,000	10 per cent.	1.24 × 100 × 5 = 620
	20 per cent.	.62 × 100 × 5 = 310

Very interesting mathematical deductions can be made showing conditions which give minimum cost, maximum efficiency, etc., but in practice these become of small value as almost in-

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THE BUILDING OF PERRET DYNAMOS AND MOTORS.

I.

FEW developments in the electrical domain of late years have been more rapid and more interesting than those which pertain to the electric motor industry. The practical utilization of electric power may be said to date from the International Electrical Exhibition of 1884, but it is only within the last two or three years that motor building has taken prominent place among the electric arts, opening up a field of activity and usefulness the limits of which no man can set. It is said by some observers that already the production of generators to furnish current for motors is larger than that of generators for lighting; and while this may not be true, it is evident that when the employment of lighting generators during daylight hours for power purposes is taken into account, the motor is even to-day well abreast of the lamp as a consumer of current. This state of affairs is in many respects matter for congratulation, and the double demand for current cannot but hasten the coming of the time when electric mains will ramify as universally and be availed of as freely as are water mains at this moment.

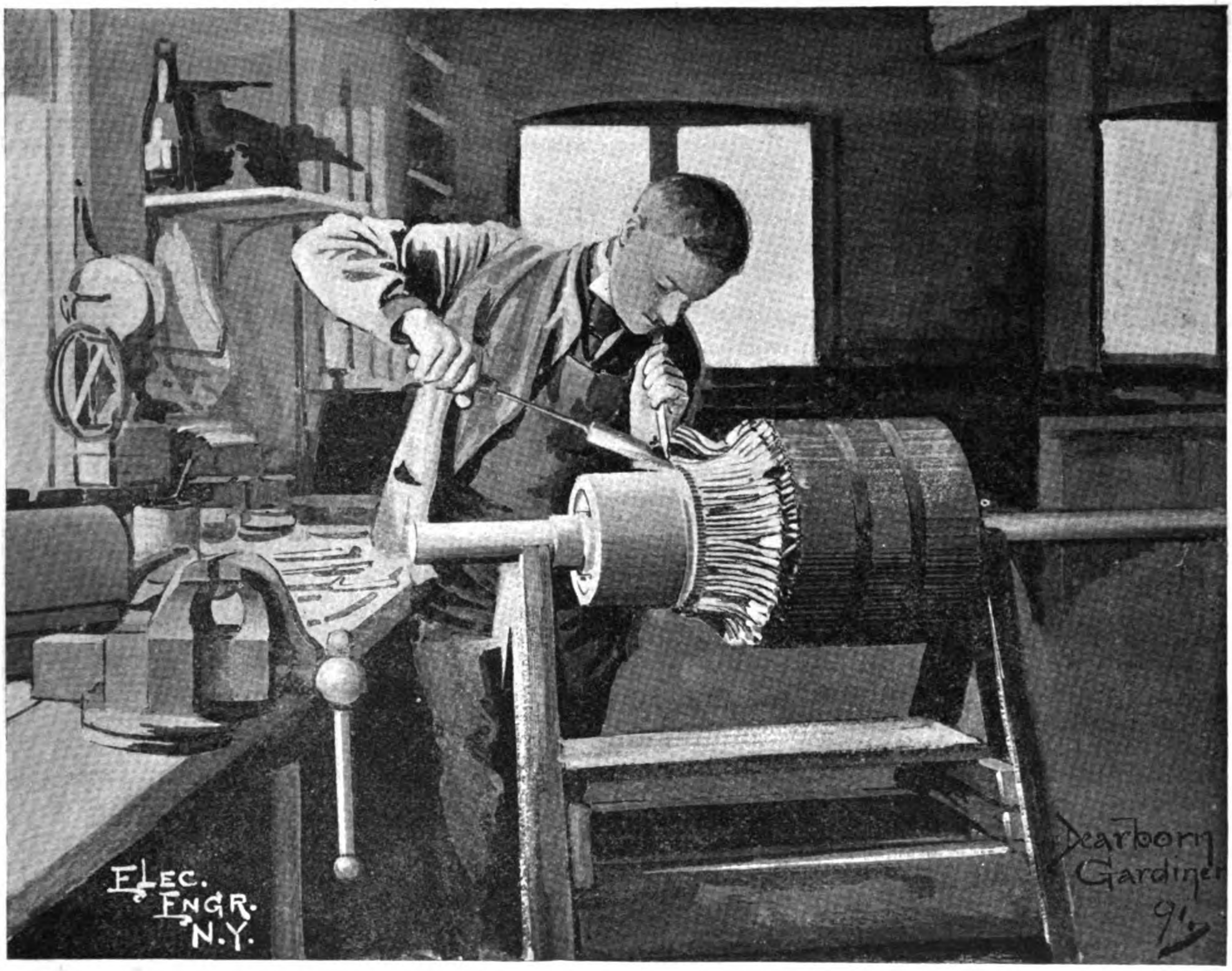


FIG 9.—CONNECTING ARMATURE COILS WITH COMMUTATOR IN A PERRET MOTOR.—(See page 6.)

The popularity of electric power has, as readers of THE ELECTRICAL ENGINEER are well aware, called various types of motors into existence, the majority of which were of the high-speed type, a feature against which no small portion of the public raised objection on the very natural ground that such high speeds rendered it difficult to effect feasible and satisfactory combinations between the driving and the driven mechanism. One of the very first inventors and designers to give attention to the production of "slow speed" motors, was Mr. Frank A. Perret, and his ideas enlisted so much support that the Elektron Manufacturing Company was formed and a large factory started in Brooklyn, N. Y. Owing to the rapid growth of the business, larger quarters became necessary, and after the inspection of a number of properties, choice was made early last year of a fine manufacturing building at Springfield, Mass., whither a removal was made during the summer. The new factory is now in full swing, and the various processes and ideas there illustrated are so important, interesting and ingenious that no apology need be offered for making here an extended description of them, setting forth standard methods of motor manufacture in America.

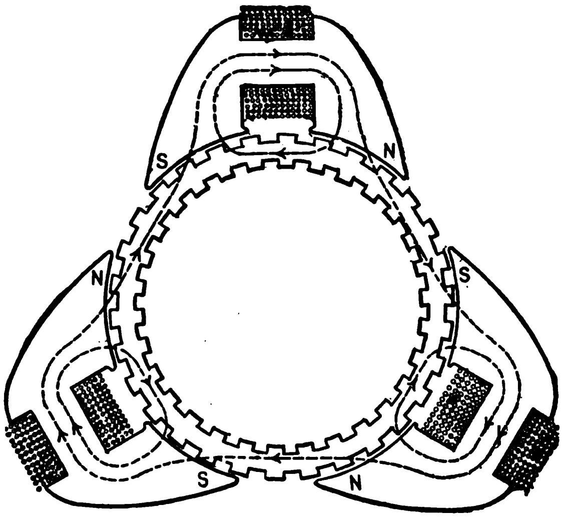


FIG. 1.—PERRET MULTIPOLAR FIELD.

II.

Before entering into a description of the method of manufacture adopted in the Perret motors, it may be well to touch briefly upon the reasoning which led Mr. Perret to design the machine as we find it. He had long recognized that the speeds at which the original types of bi-polar motors were operated were such as to lead to inconveniences and additional care in attendance at the motor, and necessitated as a rule the employment of countershafting, which always involved an additional expense whenever such a high-speed motor was installed. He had, therefore, started out at once with the problem of producing a slow-speed motor; that is to say, not to wind an armature to run slowly, but to design a machine for low speed which should have as high an efficiency as those of the high-speed bi-polar type. But how was this to be accomplished? Mr. Perret argued that in the ordinary two-pole machine the armature conductor crosses the magnetic circuit and cuts all the lines of force twice during a complete revolution, viz., where they enter the armature core at one pole and where they leave it at the other. Now, if we so dispose the magnetic circuit as to cause the lines of force to enter the armature core at one point, to leave it at another, to enter it again at a third point and to leave it at a fourth, it is obvious that the conductor will cut all the lines at four points in each revolution, and that it will, therefore, generate the same E. M. F. at one-half the original speed. If we increase the number of poles to six, we shall obtain the same effect at one-third the speed, etc., etc. This, then, is the principle of construction by which low speed is secured.

Fig. 1 is a diagram of the magnetic circuit of the Perret machine. As will be seen, there are but three magnets, each being isolated magnetically from the others excepting through the medium of the armature core, and completely isolated from the frame-work of the machine. They are formed of plates of soft sheet-iron, which are punched to the required shape and strung together on non-magnetic bolts by which they are secured to their supports. A single magnetizing coil forms two salient poles, and as each magnet is built of a large number of plates a uniform magnetic conductivity is secured. By this method of construction all danger of any inequality in the strength of the poles is avoided, and a magnetic circuit without joints and of the lowest possible resistance is secured. It is understood, of course, that in all cases the number of ampere turns on each magnet must be equal.

III.

The works, a view of which is given in Fig. 2, are situated on Wilbraham street, beside the New York & New England railroad, from which a side track is run in. The main building is of brick, 40 feet by 55 feet, and four stories high. It has a long three-story wing, 125 feet by 40 feet In this wing the workrooms are located. A brick engine and boiler-house, 45 feet square, is situated north of the main building, with a 15-foot passageway between. The 16-inch leather belt, by which power is transmitted from the engine to the main shafting, passes above this driveway in a covered bridge.

The plan upon which the machinery and the works at Springfield, Fig. 2, have been laid out is such as to effect the greatest economy in time, both as to the manipulation of the raw material and the assembling of the finished parts. In the reception of the raw material the works are peculiarly fortunately situated by having the New York and New England railroad beside them, so that the raw material can practically be unloaded directly from the cars into the shop basement floor. This first floor is a little below the level of the street and constitutes the heavy machine-room where the heavy lathes, planers and drilling machines, are situated. In this department, among other things, the rough castings are finished off and a number of special tools are employed to insure accuracy in the pro-

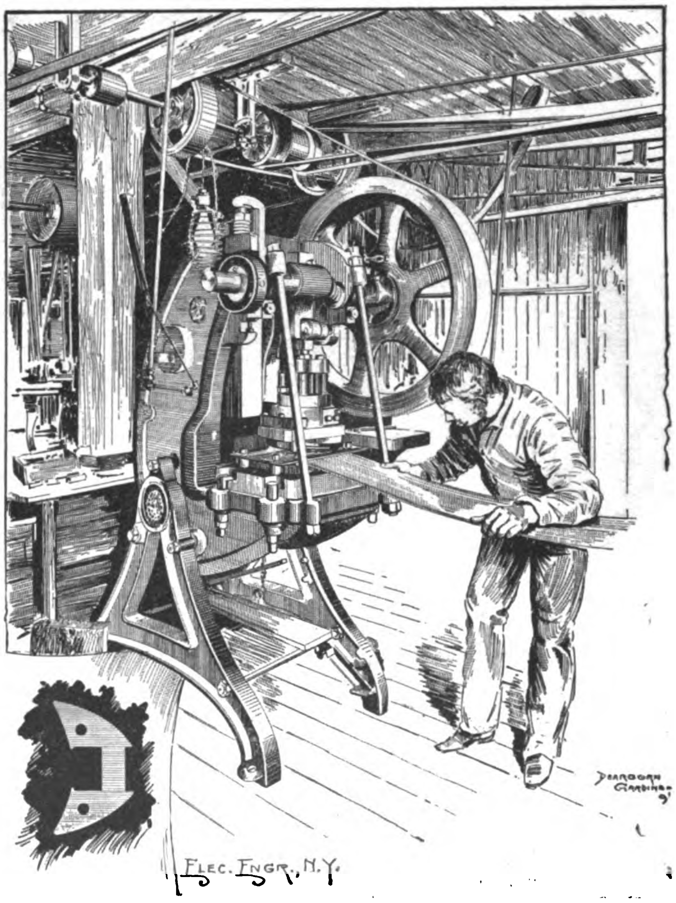


FIG. 3.—STAMPING OUT LAMINÆ FOR FIELDS.

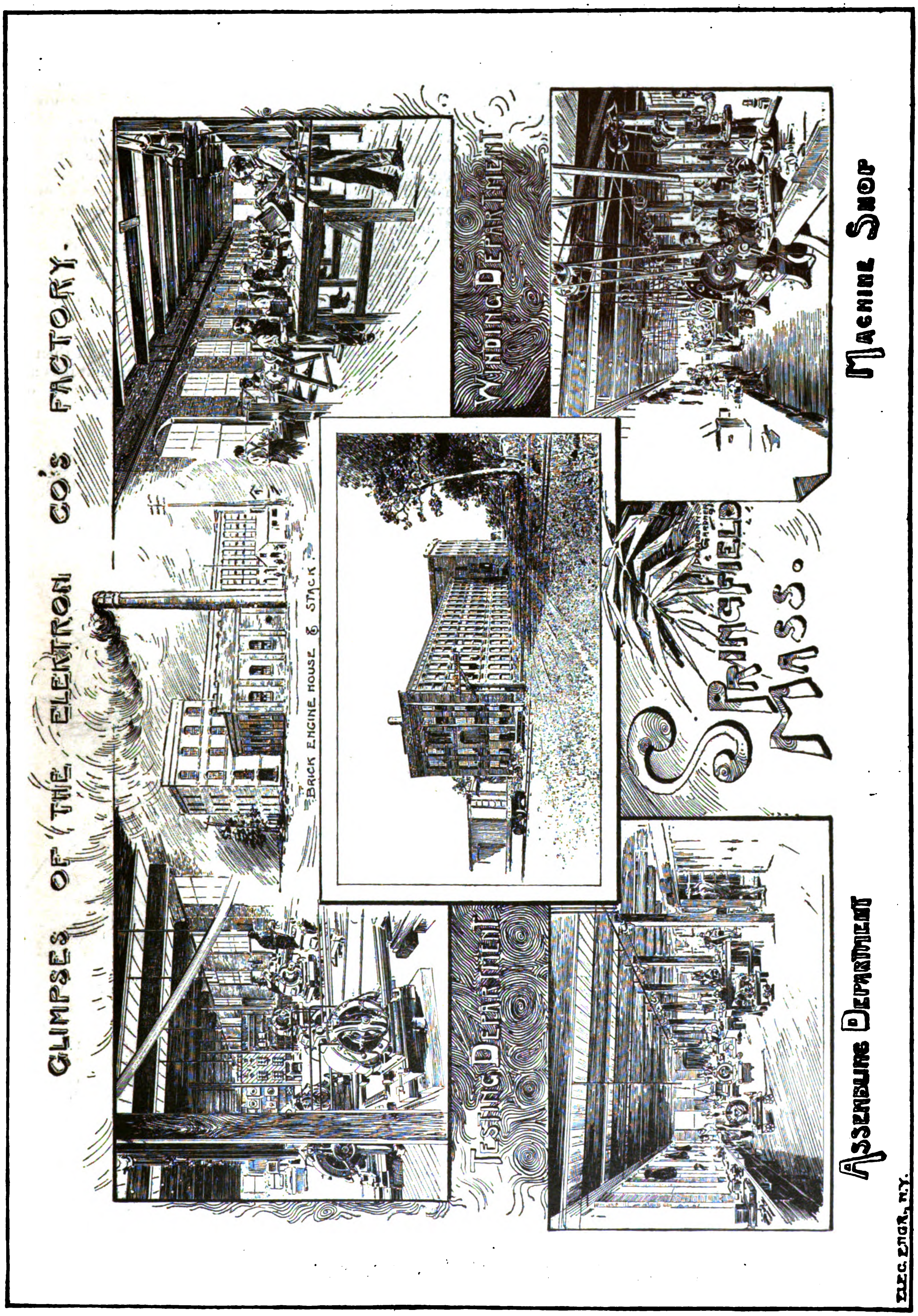


FIG. 2.—TESTING, WINDING, ASSEMBLING AND MACHINE DEPARTMENTS, ELEKTRON FACTORY, SPRINGFIELD, MASS.

ducts, as well as speed in their production. Notable among these is a special turntable "monitor" lathe, built by the Jones & Lamson Machine Works, of Springfield, which is able to take the heaviest cuts from stock and to screw thread shafts up to two inches in diameter in one operation. This machine alone performs practically automatically the work of a number of ordinary lathes attended by machinists, and on a size of work never heretofore attempted, with, of course, a large saving in time.

The engraving, Fig 2, shows the section of the machine shop devoted to the lathes and planers. On this floor also are situated the heavy presses for stamping out the sheets from which the armature and field magnets are built up. Our engraving, Fig. 3, shows one of these presses, which are able to stamp out the largest sized sheets required, and in the lower left-hand corner is shown the single stamping of the field magnet. The presses are placed close to the windows and the iron is dumped from the cars directly into a chute through the windows of the shop on to the floor. Here it is first cut up into suitable strips and then fed into the presses. Only the softest decarbonized steel is employed for this purpose, which has been rolled and pickled, and this quality of iron is used for both the armature and the field. Here we also find a well-regulated tool-room and a fireproof tool vault where the expensive dies and other standard jigs and gauges are stored, by which the work is constantly standardized in its progress and the tools kept to their correct size by comparison with the originals. The basement floor also contains the stock room where all raw material, such as castings, iron, brass, sheets, fibre and drop forgings, are kept in quantity and drawn from as the demand warrants.

Close beside this we find the room devoted to nickel plating and dipping, which the company has installed in order to avoid the delays frequently encountered in having this work done outside, and here also the polishing of the finished parts in brass is carried out. The freight elevator which passes up through the entire height of the building has its lowest landing on this floor, and is so arranged that trucks bringing in raw material back right up and deliver their goods directly upon the elevator platform, whence they are raised to the floor desired without further handling.

IV.

We will now ascend to the top floor of the building and trace the course of the work as it steadily proceeds towards the assembling-room below. This floor is devoted to the construction and winding of the field magnets and armatures.

The first operation in the construction of the field magnets is to punch the plates from the softest sheet iron that can be possibly obtained, which operation has just been described. The round holes through these plates are very carefully located and a number of the plates are then clamped together by bolts through the holes and with nuts on the same to form a field magnet, shown in Fig. 4. This constitutes one of the distinguishing features of the Perret machines, namely, that the magnets are built from plates of sheet iron instead of being made from a solid casting or forging.

The magnets thus constructed are then sent to the insulating-room where the magnet heads are applied and the magnet core and heads are thoroughly insulated by several thicknesses of canvas and tough paper prepared especially for this purpose and thoroughly shellacked.

The magnets thence pass to the winding-room where they are mounted between centres and revolved, the wire being wound on insulating and fire-proof spools, being guided by an attendant. This operation is well shown in the engraving, Fig. 4, which shows a coil almost completed.

After the magnets are wound, they are placed in a steam box and baked at a temperature of over 250 degrees until the shellac has been perfectly dried in place. Much inconvenience has been experienced in motor work, and, indeed, not a few troubles have developed, from the fact that the condition of the coils to be dried was not ascertained while the coil was in the oven. In order therefore to have an absolute means of ascertaining when the baking process is complete, the following arrangement has been adopted: Wires from the testing-room are led into the oven, one end grounded and the other touching one terminal of the wire coil. In the testing-room, one terminal is also connected to ground and the other connected to the coil in the oven. Upon closing the circuit there will evidently be a deflection if the coil has not been thoroughly baked, and the coils are thus always allowed to remain in the oven until the galvanometer shows that they are thoroughly dried. This method leaves no room for doubt and not only insures the perfection of the operation, but also saves time by allowing the coils to remain in the oven no longer than is absolutely necessary.

The coils are finally filled with shellac and then again dried. This process is so thoroughly done that it is almost impossible for any moisture to enter the coils of the magnet.

V.

While this work has been going on in the winding-room, the cast iron frames upon which the magnets are mounted have been finished in the machine department. These end frames carry the bearing in which the armature shaft revolves, and are plainly shown in Fig. 5.

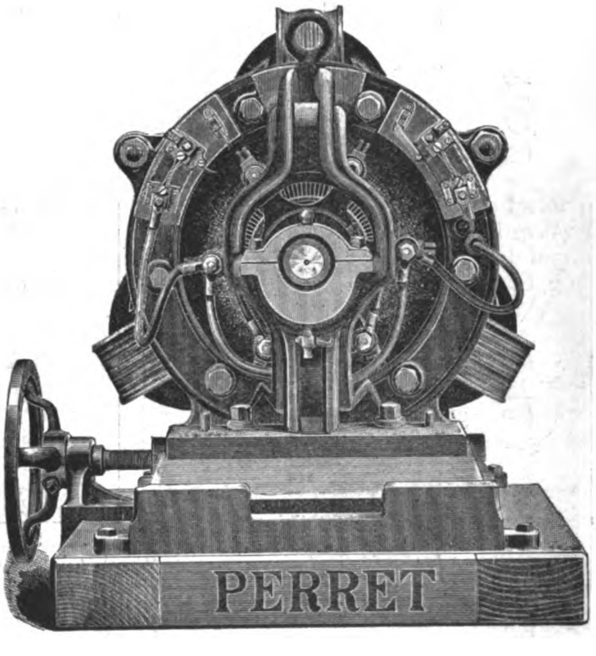


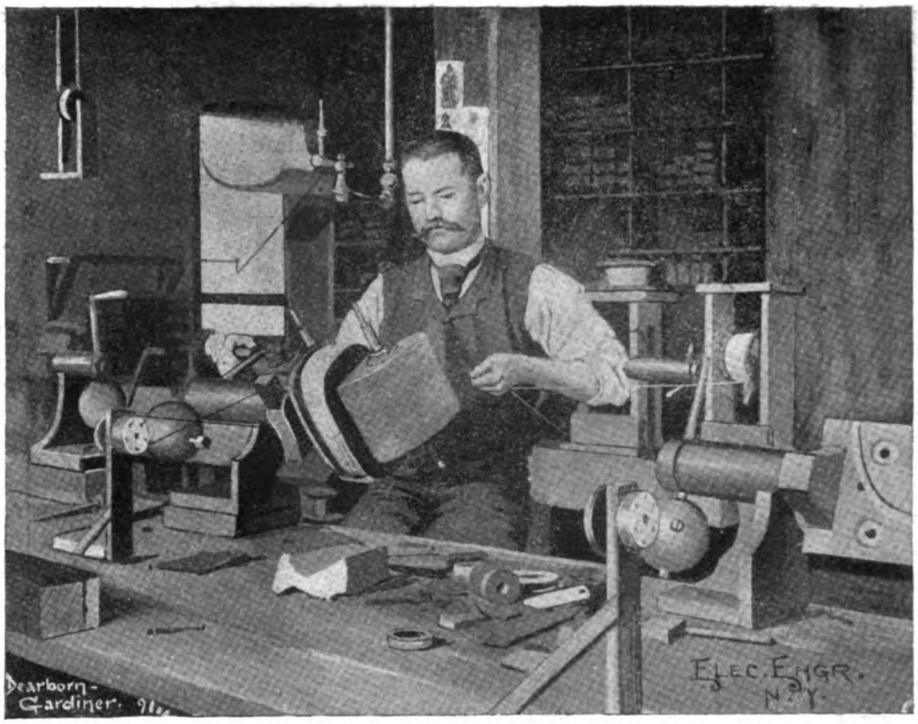
Fig. 5.—End View of Perret Low Speed Multipolar Motor.

The same bolts which pass through the plates of the magnets binding them together, project through holes accurately located and drilled through the end frames and thus the field magnets are supported in perfect alignment with the armature.

There are three field magnets arranged at equal distances around the periphery of each armature. A bolt passes through the polar portions of each field, making two bolts to each magnet, six to each machine. The ends of these bolts are plainly seen projecting through the frame in the end view, Fig. 5.

The cast iron end frames are now bolted upon a cast-iron base which has been prepared to receive them. This base is so constructed that it slides in two cast iron ways or tracks which are bolted upon a wooden-base frame. The hand-wheel and screw are designed to force the machine in either direction on these tracks in order to loosen or tighten the belt which runs on the pulley of the machine.

The bearings of each machine are provided with a simple device by which they oil themselves. It consists of a brass ring of larger diameter than the shaft and which hangs upon the shaft inside the bearing and dips down into a chamber filled with oil. When the shaft revolves the ring revolves slowly and keeps the shaft constantly oiled. The only attention required is to change the oil every week or two.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Elec. Engr. N.Y.

Fig. 4.—Winding a Perret Field Magnet.

VI.

The armature, that most important part of every dynamo-electric machine or motor, receives the most careful consideration in the Elektron Works. Its construction is commenced by cutting off a round bar of best quality steel to the proper length for the shaft and then carefully turning it in a lathe to the proper diameter; after this, keyways or slots are cut in it by which the armature proper and the commutator may be mounted upon it. The plates are then punched out with which to build the armature core, being punched from the same quality of sheet iron as the field magnet plates. In order that the machines may be very efficient it is necessary that this iron should be of very high magnetic permeability.

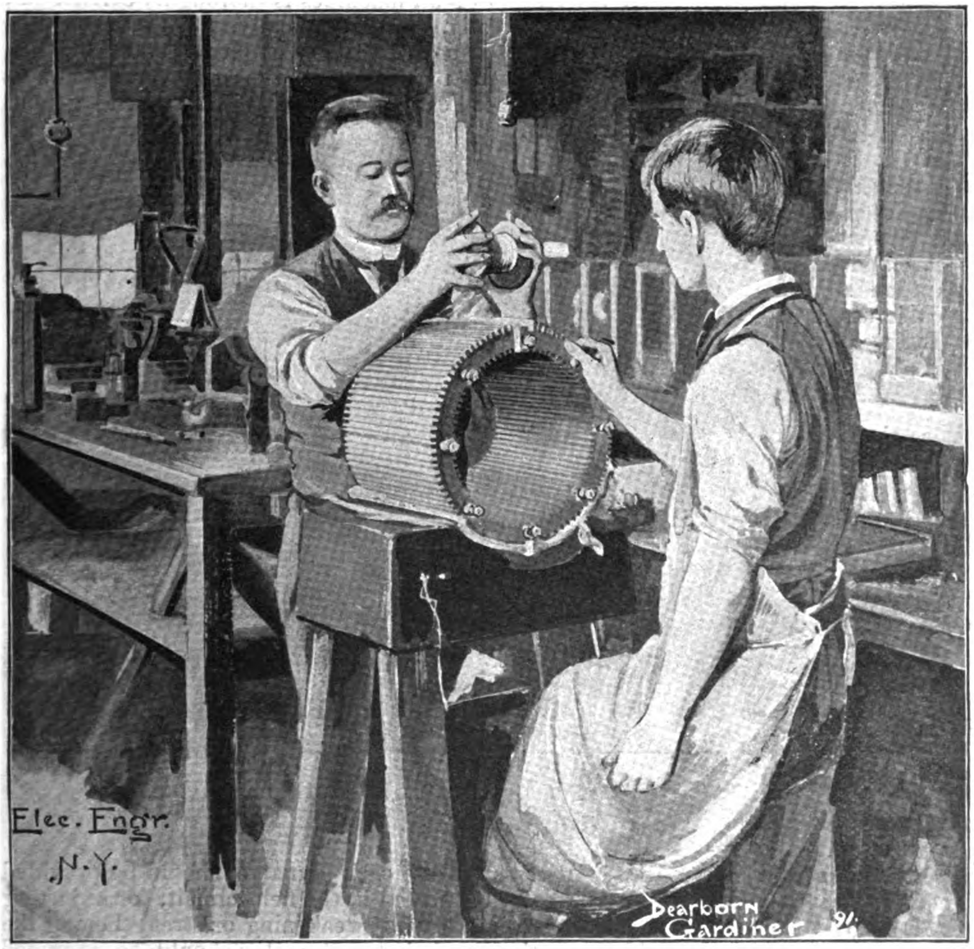
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Fig. 6.—Winding a Perret Armature.

The armature plates are ring-shaped with teeth on both the outside and inside of the ring. The appearance of the armature core after being built up from these plates by bolts passing through them is shown in Fig 6, and the channels formed in the periphery of the core by the teeth on the plates may also be clearly seen. The plates are held together and formed into a cylinder by screwing up nuts firmly on the ends of the eight insulated bolts which pass through them; and these same bolts serve also to attach the armature to the shaft by means of a disc or "spider" of gun metal at each end. Each spider is bored out to fit the shaft and has eight holes bored to fit the eight bolts.

The armature core is now ready to be insulated and wound. The insulation is very simply effected by means of what may be called a trough of insulating material which is slipped into each channel on the outside and also on the inside of the ring, after which a spool of magnet wire is taken and the winding is commenced. For each channel on the exterior of the ring there is a corresponding channel on the inside, and the depth and width of these channels are just right to contain the proper number of turns of wire.

The method of winding is clearly shown in the illustration, Fig. 6, one man drawing the wire through on the inside and the other pulling it over on the outside until the channel is filled. After filling one channel the end of the wire is passed onward to the next.

It is of the utmost importance in electrical machines that the wire shall be of sufficient size to carry the full current without heating and that it shall be so perfectly insulated that there shall be no contact between adjacent wires or with the iron core of the armature. Also that it shall be held so rigidly that it cannot be shifted out of place by any strain that may be thrown upon it. This is all facilitated by the plan of winding the wires in channels instead of winding on a smooth round periphery as is sometimes done. After the winding of the armature is completed it is dried, shellacked, and dried again, the same as in the case of the field magnet.

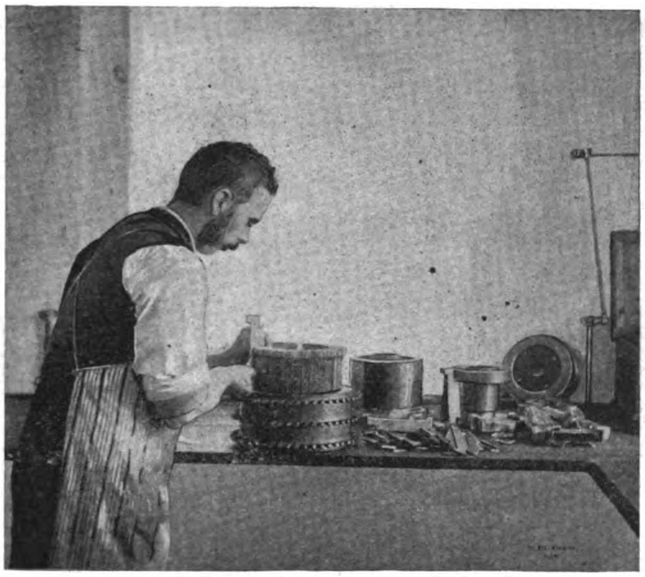


FIG. 7.—BUILDING UP A COMMUTATOR.

In order to mount the armature upon the shaft one of the spiders which we have previously described is bolted to each end of the armature ring by means of the same bolts that pass through the core and clamp the plates together, and the whole is then slipped upon and keyed to the shaft. The commutator is then slipped upon and keyed to the shaft.

VII.

The construction of the commutator, the tender spot in every continuous-current machine, is an operation requiring the greatest care. A single error, which might not appear on the surface, might be enough to cause serious trouble in the working of the machine. The method here adopted is illustrated in Fig. 7, showing the process of building up a commutator from the copper segments, a pile of which may be seen on the bench at the workman's right. Each of these segments must be set in its exact place inside the ring-shaped fixture, and it must be thoroughly insulated by a solid layer of best quality mica from every other section and also from the two end discs between which it is clamped. When all put together the commutator has the appearance shown in Fig. 8, which shows it mounted on a mandril undergoing its final turning in the lathe. The segments are all formed of the purest copper, and are provided with lugs which are slotted to receive the armature coils. Fig. 9 (page 1) shows the armature of a 20 h. p. motor and commutator for the same mounted on the shaft, which is supported upon a "horse," while the workman is engaged in soldering the armature coils to the commutator segments, an operation requiring considerable care and skill.

One of the most interesting features of the Perret machines lies in the fact that for all sizes of the machine between 4 and 20 horse power, but one diameter of armature, namely, 14 inches, is employed, the various sizes being built up by increasing the length of the armature; and in a like manner increasing the width of the pole-pieces by adding more sheets, according to the length of the armature. The great economy effected by this method of construction is so obvious as to need no further pointing out, and it will also be conceded that the designing of the teeth to meet the requirements of the space required by the various sizes of wire with which each machine is wound shows the highest skill in the design of the machine.

VIII.

We now descend to the floor below, where we find the assembling department. Here the heavy parts of the machine are brought up from below, and the magnets and armatures brought down from the floor above, where they are assembled, the parts being fitted together and bolted into place. Upon these operations our engraving, Fig. 10, shows a workman engaged, fitting brasses to the bearings of the motor. After this fitting it only remains to place the armature in position, connect the wires and start up the machine.

The motor is now ready to be transferred to the testing department, which is also situated on this floor, and a view of which is shown in Fig. 2. This testing department still employs, as a generator, the first 15 h. p. multipolar Perret machine built, and its continuous active service is probably as good a proof as could be found of the general excellence, both in design and workmanship, of this machine. Here the testing of all machines is thoroughly carried out, not only electrically, but mechanically. For the latter purpose an Emerson power scale is employed and every machine is put through a continuous run of several hours at more than its rated capacity before it is allowed to go out of the works.

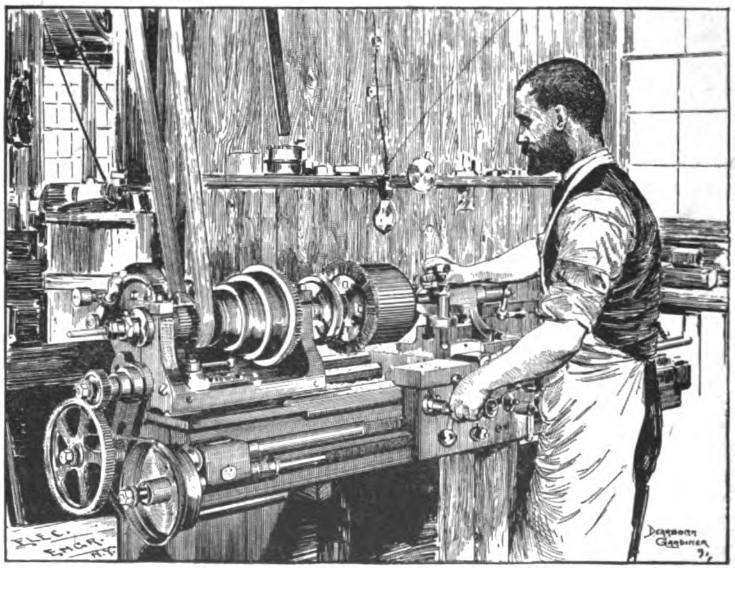

ELEC. ENGR. N.Y.

FIG. 8.—FINISHING COMMUTATOR IN LATHE.

IX.

It is necessary that each dynamo should be provided with a rheostat connected in the field circuit, for adjusting the electromotive force by weakening or strengthening the field magnetism, and that each motor should be provided with a rheostat or starting box in the armature circuit to

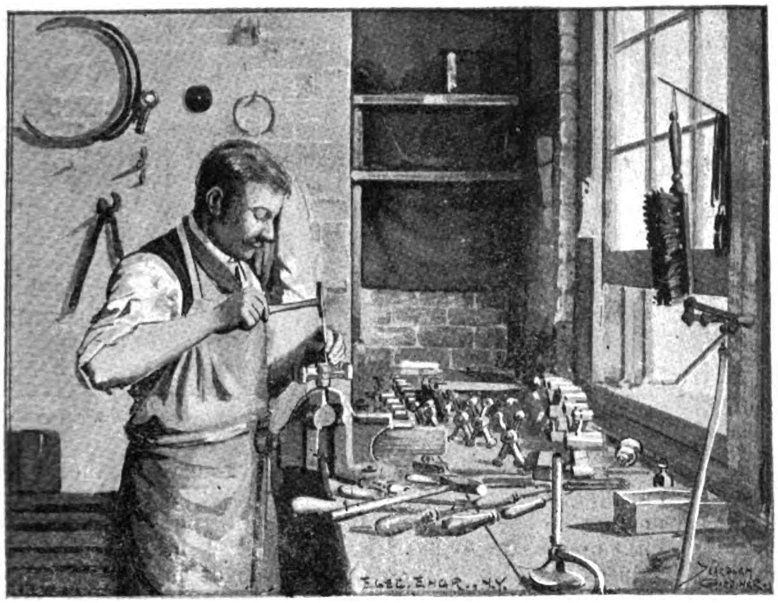

ELEC. ENGR., N.Y.

FIG. 10.—FITTING A MOTOR BEARING.

prevent an excessive rush of current on starting up the machine. The construction of these rheostats has been the subject of special study in order to provide an apparatus which should be absolutely incombustible. The necessity of this is evident when it is considered that machines are frequently placed in the care of ignorant persons, and rheostats intended to be placed in circuit for a few moments only, are left with the full current turned on for hours. As a result of this experience, the Elektron Co. make all their rheostats and starting boxes entirely of non-combustible material. The resistance coils are of German silver or galvanized iron wire, which are supported in the iron box by porcelain bushings, and the contact plates are of brass on a slate base. The engraving, Fig. 11, shows the method of conducting these rheostats, which have now become one of the standard products of the Elektron Co.

X.

A very important point in connection with all dynamo machinery is the brushes, and this has also engaged the special attention of Mr. Perret. Instead of using a solid carbon block a series of carbon pencils are employed, where the work to be effected is light and intermittent in its nature. For heavy and constant work, however, Mr. Perret has found the carbon block to be most efficient, when certain precautions are observed. Principal among these is the securing of a good connection between the carbon and the circuit wire. For this purpose the carbon brush is connected directly to the terminal wire by a short length of flexible cable, so that, having free movement under the influence of the springs, it forces itself against the commutator, the spring and the holder in which the carbon slides not being called upon to carry any of the current. The result is that the heating noted at the brushes where the latter take their current from the holder direct is practically overcome. Where the voltage is under 110 volts and heavy currents are to be carried, Mr. Perret still prefers the copper brush.

XI.

The engravings, Figs. 5 and 12, show the standard Perret multipolar dynamos and motors, as at present constructed. In all essential points the construction is the same as that of the first machine which was brought out about two years. The only changes which have been found necessary have been in the minor details of the frame. In this respect the machines are quite remarkable and are a constant testimony to the genius of Mr. Perret as a designer.

The production of the company consists very largely of these multipolar machines and during the past year the demand for them has been rapidly increased, not only for use as motors but also as dynamos for isolated plants, for which purposes they possess unusual advantages by reason of their high efficiency, perfect regulation and the small attention required. In these machines the reduced speed is obtained without increase of weight or of space over the ordinary, and for this reason the dynamos are in great demand for places where economy of space is important, as on shipboard.

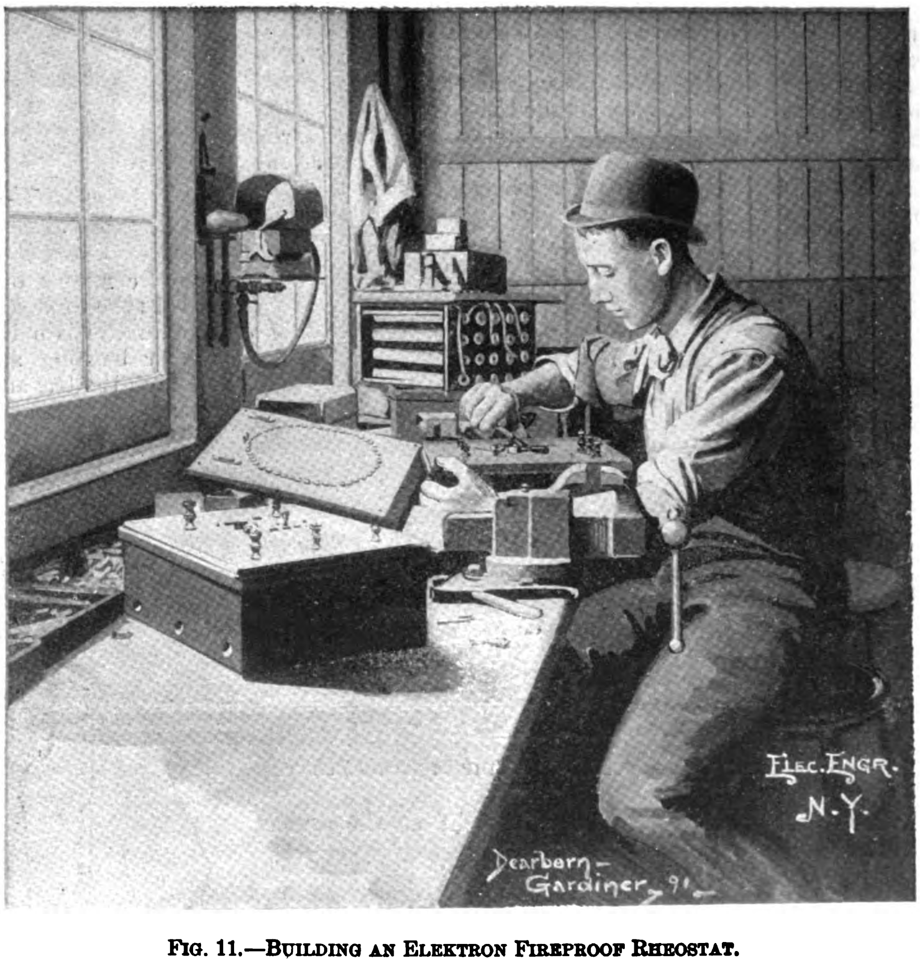


FIG. 11.—BUILDING AN ELEKTRON FIREPROOF RHEOSTAT.

One of the most important attributes of any machine, whether used as a dynamo or as a motor, is its regulating qualities. For incandescent lighting the desirability of closest regulation is obvious, and on the other hand, an electric motor whose speed is not uniform at all loads does not fill the requirements for most purposes. Perhaps the best way of demonstrating the regulating qualities of the Perret machine was that embodied in a test shown to the writer at the works of the company during a recent visit. The machine in question was coupled direct to a steam engine, the plant, illustrated in Fig. 13, being intended as a marine electric lighting plant. At the writer's suggestion the machine was loaded to its full capacity and the main switch opened and closed successively. In neither case could a variation of more than a small fraction of a volt be detected upon a Weston voltmeter. This type of marine plant will shortly be installed in a number of yachts and steamships, and it is safe to assume that it will form an important branch of the business of the Elektron Company. Certainly every one noting such a test must be impressed with the perfection to which the regulation of dynamos and motors has been brought at the present time.

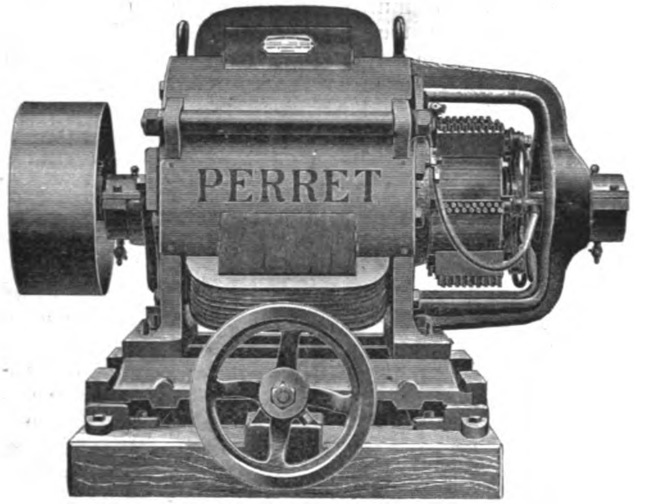


FIG. 12.—SIDE VIEW OF PERRET LOW-SPEED MULTIPOLAR MOTOR.

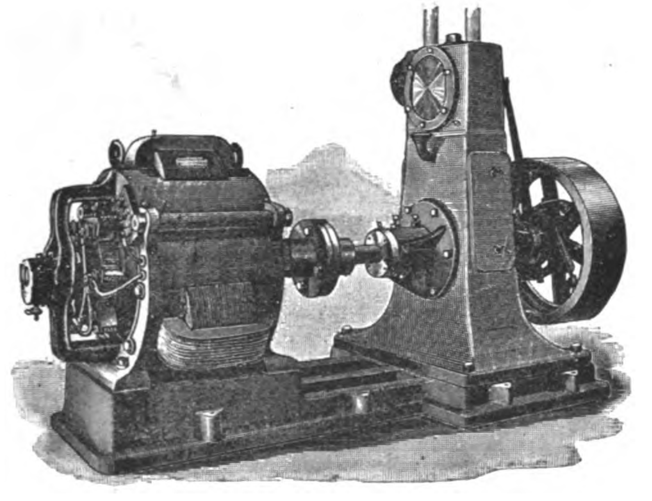


FIG. 13.—DIRECT CONNECTED PERRET SHIP LIGHTING PLANT.

XII.

There are many situations in which a machine developing from ¼ to 2 h. p. is required, and for this purpose the type illustrated in Fig. 14 has been designed and is regularly built at the Elektron Works. It is of the bi-polar type and, like the multipolar machines, has both its field and armature built up of soft laminated iron.

"Not a little attention has been bestowed by Mr. Perret upon the design of motors for small powers, such as the driving of fans, sewing-machines, jewelers' lathes, etc.

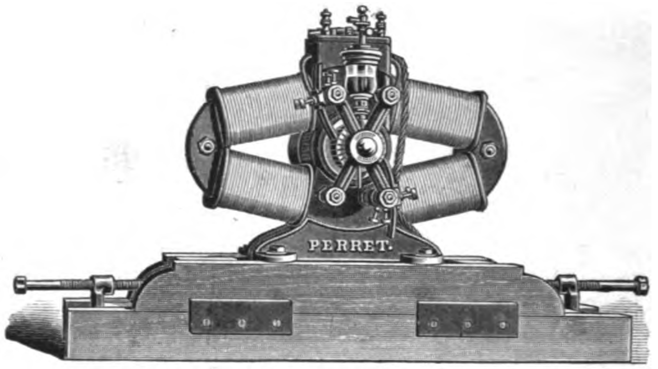


FIG. 14.—TYPE OF ¼ TO 2 H. P. PERRET MOTOR.

The same principles which have led to success in the larger machines are also embodied in these. Fig. 15 shows the manner in which the field magnets of these pygmies are built up and Fig. 16 shows a Perret ⅛ h. p. fan motor mounted on a base. Special methods of manufacture are employed in the construction of this type. For the small size of commutators employed on the fan motors, the dovetailed type of segment is not employed. In its place the commutator is built up by placing the segments on a hard rubber bushing and driving in brass pins at the ends through the bar and into the fiber. This holds the segments securely, and largely reduces the cost of manufacture. One of the features of the armatures of these machines is the peculiar spiral form given to the grooves in which the wires are wound. The pitch of this spiral is so

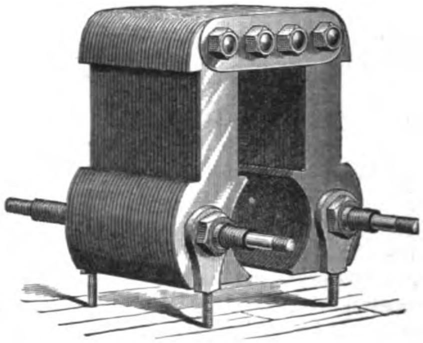


FIG. 15.—FIELD MAGNETS OF SMALL MOTOR.

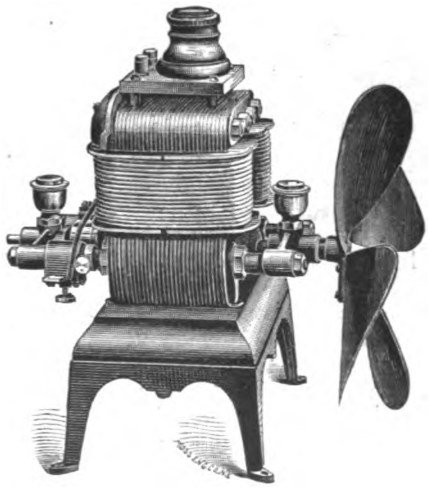
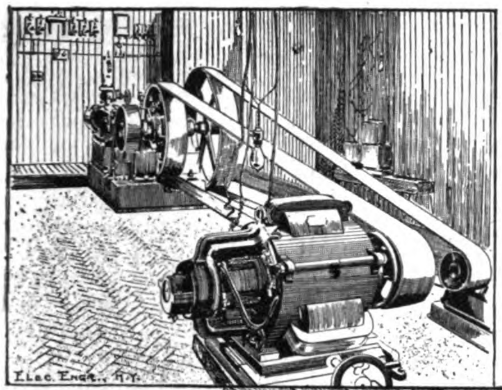


FIG. 16.—⅛ H. P. FAN OUTFIT.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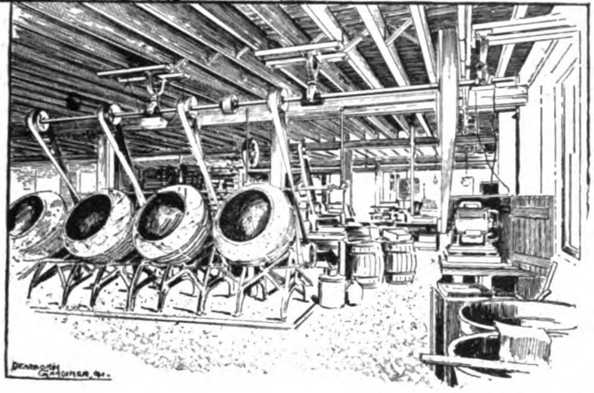
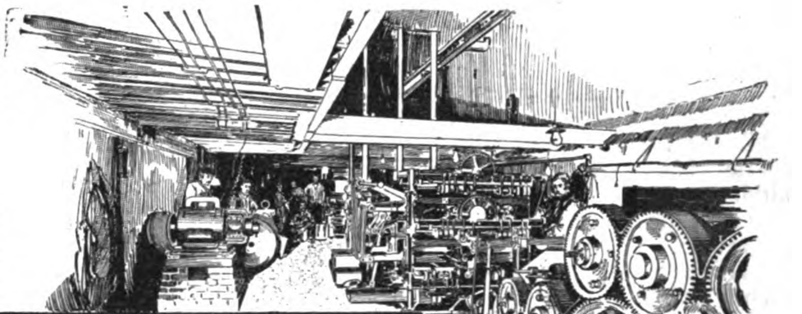


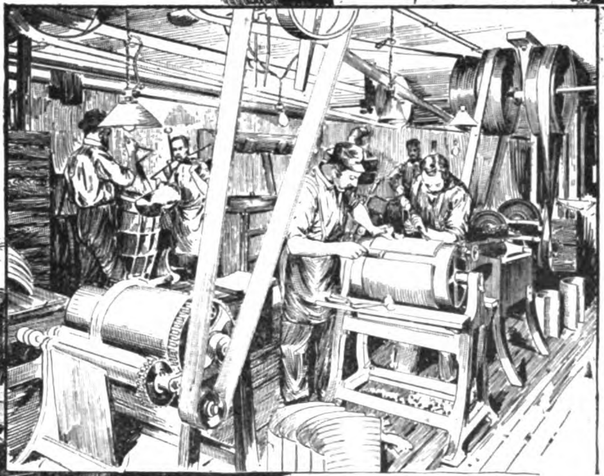
arranged that the end of one tooth leaves the edge of the pole-piece at the instant that the beginning of the next comes under it. In this way the lines of force emanating from the pole-piece are not broken abruptly, as would be the case if the teeth were parallel with the edge of the pole-piece, and as a result the action of the motor is smooth, heating of the pole-pieces is avoided, and a great deal of noise dispensed with.

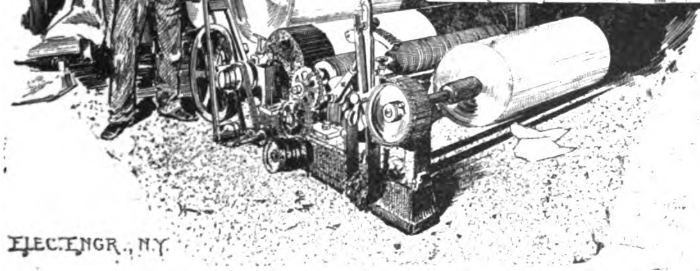
XIII.

Among other things indicating the progressive spirit of the Elektron Company is the arrangement which has been entered into by them experimentally with the Springfield Trade School. Under this arrangement the company receive into their shop twenty apprentices or students, and agree to give them the opportunity to learn the machinist's trade during a period of three years, during which the young men work in the shop one-half time and devote the other half to a special course of study in such branches as would be of most service to them in the mechanical line. The students are grouped into two divisions, one of which works one day in the shop and the other the next day and so on.

It has been a cause for regret that there has seemed to be in our present industrial system nothing to take the place of the old apprentice system which has practically passed out of existence, but this arrangement at the Elektron shops, if it proves successful, and it now appears so, will prove a solution of the problem. At all events the scheme is creditable both to the managers of the Elektron Co. and to the school. Of course the number of students at work at one time must of necessity be confined to a small percentage of the whole number of the employees, as it is not practicable to do a very large proportion of the work by students. But this new departure seems to us one of the most hopeful that has been made of late years in regard to the training of artisans, and we think it will be closely watched by economists of all schools.



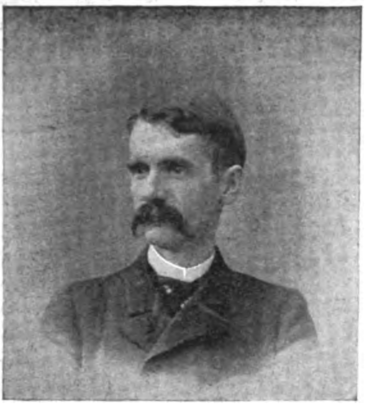



ELEC. ENGR., N.Y.

FIGS. 17 AND 18.—A NEW ENGLAND CANDY FACTORY, AND THE PRESS ROOMS OF NEW YORK COMMERCIAL ADVERTISER. OPERATED BY PERRET MOTORS.

XIV.

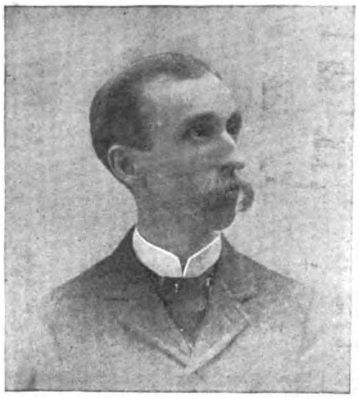
Two features are conspicuous in the construction and operation of nearly all American mills and factories at the present time. If steam is the means of distributing motive power, long and heavy lines of shafting obtrude themselves upon the eye, combined with an endless maze of belts; and the mill itself hugs closely the railroad from which it derives its supply of fuel. If water is the prime energy, not only is the mill festooned in belting but it is huddled down close to the stream, sacrificing light and air for the sake of getting power cheaply. Hitherto it has been taken for granted that these and allied conditions are permanent and must be dealt with in all power transmission within buildings. The assumption is, however, so far from the truth that new mills equipping for power transmission by other than electrical methods may safely be said to illustrate the ideas of the past rather than the practice of the future; and the work of transformation and transition has already been begun with such vigor that even now the adoption of electric motors for mills and factories promises to be as rapid as was the introduction of the electric light. But ten years ago the use of electricity as an illuminant in a mill was still a decided novelty, not a little scouted and frowned down upon. To-day it is without a rival in popularity. A similar course of events may be looked for with regard to the use of electricity for power



W. D. Sargent.

transmission, except that the stages of advance will be the more rapid because in a great many instances the existing circuits for lighting are of capacity enough to carry ample current for motors also.

The work of the Elektron Company furnishes more than one example of this peaceful revolution now going on, and that which we here illustrate in Fig. 17 is typical in many respects. The cut shows the factory or B. H. Douglass & Sons, at New Haven, Conn. The business of this company is the manufacture of confectionery. The entire factory is operated by electric power, the plant being installed by the Elektron Company, from the plans and under the superintendence of Mr. George G. Grower, electrical engineer, of Ansonia, Conn. One of the views here given shows the 25 h. p. steam engine belted to a Perret generator, which is compound wound for 110 volts and supplies current to the Perret motors located in various parts of the works. The dynamo and the motors are all of the six-pole, low-speed type. The 4 h. p. motor on the first floor operates the elevator. A 2 h. p. on the second floor drives blowers and machines used in the manufacture of fruit tablets, which are here made in great quantities. On the third floor a 4 h. p. motor drives two cocoanut grinders; another 4 h. p. motor is used for stirring candy in the steam kettles; while the 7 h. p. motor shown in our other view is used to rotate what are called the plum pans, seven in number, although only four of them are included in the engraving. This plant has now been in operation about nine months, with a marked saving in coal consumption, and with a keen appreciation of the many advantages that electric power brings with it.



E. H. Cutler

XV.

So interesting and important is this work of electric power distribution that we may be forgiven if we direct attention to another striking plant installed by the Elektron Co., who have the honor, unless we are greatly mistaken, of being the only motor builders whose machine prints a great metropolitan daily newspaper. Our illustration, Fig. 18, shows the press rooms of the *Commercial Advertiser* of this city, where a 20 h. p. slow-speed Perret motor runs a large portion of the establishment. Early this year the idea occurred to Mr. Harold Godwin, then editor of that century-old evening paper, that it would be an advantage to use electricity to run his presses, and he did the editors of THE ELECTRICAL ENGINEER the honor of consulting them on the subject. Encouraged by the advice and information he received, Mr. Godwin lost no time in making his arrangements, and on taking possession of a large new office he installed the Perret motor, together with a Corliss engine of 50 or 60 h. p. which was to operate the supplementary apparatus and to answer as a reserve. The electrical plant was put in last April, and was started almost immediately. The equipment of the pressroom comprised a large Hoe perfecting press, capable of throwing off 25,000 copies an hour, two Cottrell presses, capable of printing 15,000 an hour each, and one wetting machine, all these being on one floor in the basement, in Park Row, and driven from a main shaft directly from the motor, without the intervention of any countershafting. Besides these heavy pieces of mechanism, there were on the floor above an outfit of regular stereotyping machinery and a 48-inch ventilating fan, all run by the same motor.

This Perret motor was put in by Mr. Godwin to run the single Hoe perfecting press, but it tackled that load with such a light heart that the two Cottrell presses were added. On a sudden emergency, when no steam was available, the wetter, stereo-machines and fan were also heaped on its sturdy back, but it shouldered the whole so satisfactorily that the practice has been continued. Shortly after this plant was started, Col. Cockerill bought the *Commercial Advertiser* and started the *Morning Advertiser* which has already secured so firm a footing among the popular morning dailies of New York, and for a time the motor printed both the morning and the evening editions. But the success of the morning paper soon outran the old facilities and lately a big new Hoe press has been added to which the spare Corliss engine has been connected so as to get the full benefit of the existing equipment. The Perret motor has, however, made a most striking success in keeping with the progressive journalism that it has been called upon to aid; and it is believed that at no distant date electric power will handle not only the *Advertiser* but other large dailies in this city. It may be added that the motor is on the regular 110 volt Edison circuit and draws current from the old mains along Park Row. As the readers of THE ELECTRICAL ENGINEER are aware, the use of electric motors in printing offices, thanks to the increasing availability of electric cnrrent, is growing rapidly in the larger cities of the Union, a fact which speaks volumes for the motor, in view of the delicate and difficult nature of the work, which compares in many respects, and especially in its rapid variations of load, with street railway work.

Frank A. Perret.

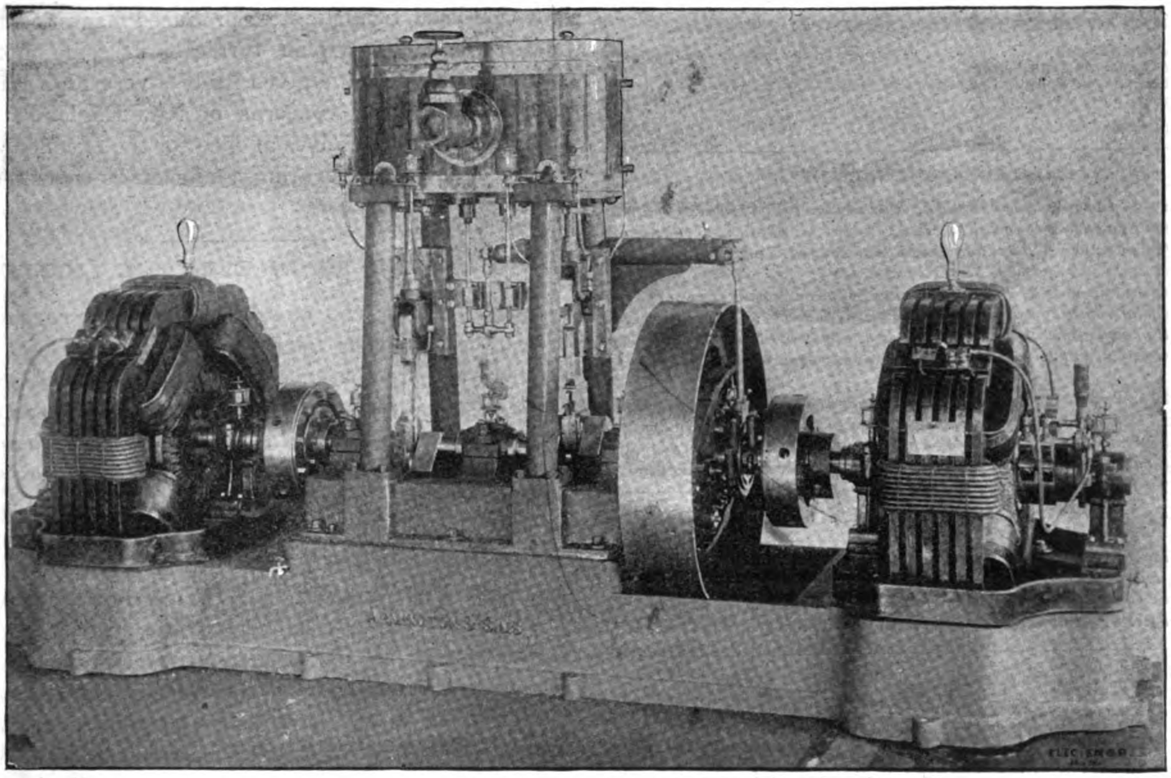
XVI.

A word by way of conclusion may not inappropriately be devoted to the personnel of the management of this progressive company, and we are glad to present here portraits of the leading officers. The president, Mr. W. D. Sargent, is not only an old telegrapher, but a pioneer telephonist, and is actively connected at the present time with the telephone companies of Long Island and New Jersey. Mr. E. H. Cutler, the treasurer and manager, has been associated with the company from the inception, and the same is true of Mr. Frank A. Perret, its electrician and electrical engi-

Leon J. Harley.

neer. Associated now with these gentlemen is Mr. Leon J. Harley, as general superintendent, a position for which a long training in the manufacture of small arms qualifies him in a special manner. The company have as selling agents, J. U. Burkett & Co., in Washington; George Baquie, in New Orleans; the Electrical Engineering Co., in Chicago; F. J. Renz, in St. Paul, and the Pennsylvania Machine Co., in Philadelphia. They have also large offices in New York under the care of Mr. Robert Watson, among whose installations may be named one of 185 lights in the building on Liberty street, where his headquarters are established, and through whom the company now have orders on hand for the equipment of a number of steamships with dynamo and engine coupled direct on one base.

The number of Perret motors now in operation in all parts of the country will figure up to several thousand and they are used for every conceivable purpose. Most of these machines are shunt wound for giving constant speed in cases where this is an important requirement, but there are many in operation that are wound to suit special work.



New Thomson-Houston Direct-Connected Marine Plant, with Armington & Sims Engine.

NEW THOMSON-HOUSTON DIRECT-CONNECTED MARINE PLANT.

We illustrate in the accompanying engraving the combination of the Thomson-Houston multipolar marine dynamo with the double upright Armington & Sims engine, connected directly to the armature shaft by an insulated flexible coupling. This combination has, it is claimed, in the opinion of the Naval Board of Electrical Experts, shown greater efficiency than any other combination of the kind they have ever tested. Over sixty of these plants have been constructed which have been illustrated and described from time to time in the Engineer. A slight change has, however, been made from the single to the double dynamo in the steamer "Fairfax" of the Merchants' and Miners' Transportation Co.

The object of the builders was to furnish a plant as compact as possible, and the preliminary test indicated that the departure had been successful. The floor space covered by the engine and dynamos is three by ten feet, a saving of nearly one-half as compared with steamship plants previously furnished. This economy of space was gained by coupling two dynamos to one engine.

The dynamos are of the Thomson-Houston multipolar marine type, 110 volts, and each has a capacity of 10,000 watts. Both dynamos will be in service when it is desired to call into use the entire capacity of the ship, and in addition to lighting the vessel, they will supply a search light of 4,000 candle-power which is automatically operated from the pilot house. By the search light, buoys can be located from three-fourths of a mile to a mile, and the lights can be seen at a distance of fifteen miles from the vessel.

The dynamos are driven by a seven by five inch double upright Armington & Sims engine, which has a speed of five hundred revolutions a minute. The entire marine plant, which weighs seven thousand pounds, is a duplicate of those furnished the Navy Department for the new cruisers, one to three of which were placed upon each vessel. There is this difference, however; the Government engines have one dynamo connected to each engine by a flexible coupling, while the electric plant of the steamer "Fairfax" has a dynamo directly connected to each end of the engine shaft. This plant has been installed and is now in successful operation.

THE ELECTRICAL UTILIZATION OF WATER-POWER AT MARBURG.

A project is on foot, suggested by the success of the Lauffen-Frankfort experiment, for conveying 600 h. p. by electricity from Marburg to St. Lorenzen, a distance of 18 miles. A head of water, over 200 ft., is available at the former place.

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Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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It cannot be impressed too forcibly, both upon the student in mechanics and upon the workman, that accuracy of measurement is essential for good and efficient workmanship, and that it tends to economy in all branches of manufacture.—Sir Joseph Whitworth.

THE ART OF MOTOR BUILDING.

THE electric motor industry is still in its first decade, but it has made enormous strides and to-day constitutes one of the most active, popular and progressive fields of work in the whole domain of electricity. An evolution, strictly, of dynamo design and construction, it has yet developed many special features and principles of its own, the importance of which is daily proved in the highly ingenious and successful machines that furnish power to hundreds of different industries throughout the length and breadth of the land, either taking current from central stations or else constituting a part of some concentrated factory system of power distribution.

The art of motor construction is therefore to-day a new story, and the chapter of it presented in our description of a recent visit to the new works of the Elektron Co., at Springfield, Mass., brings out many points of great interest. The region in which these works are located is famous for the perfection of its small arms, and in various respects the electric motor belongs in the same category of fine work, intelligently designed and skilfully turned out. The motor industry, in fact, bears with its right on the sewing machine and small-arms branches of industry, and on its left is in touch with the heavy engineering of compound steam engines, and this range is one of its largest elements of promise.

A special point of interest in our article will be found in the description given of the manner in which the Elektron Co. has allied itself with the Springfield Trade School, so as to admit a limited number of students into its works for technical and mechanical training. This is an admirable departure—one, indeed, so new and novel that we do not quite see where it is likely to end. It is certainly a very ingenious and laudable attempt to give us the new system of apprenticeship of which this and every other manufacturing country so sorely stands in need ; and we are glad to know that so far it is working successfully. Nowadays we hardly expect any one to go through the old seven years of drudgery that belonged to apprenticeship ; but that hard, trying system produced magnificent artisans; and if the Elektron plan furnishes us some more of the old breed it will have given itself a very high rank among the manufacturing concerns of New England that have distinguished themselves at once for the excellence of their product and the elevating tendency of their social influences.

CONDENSERS IN ELECTRIC LIGHTING.

AMONG those who closely watch the progress of the times, the increasing importance of the condenser in nearly all electrical applications must have attracted more than usual attention during the last few years. This early adjunct to telegraphic apparatus has already vastly changed telegraphic methods and increased their scope, especially in submarine work; and it now bids fair to have a not unimportant bearing upon the future methods of electrical distribution of light and power. It is some years ago that Mr. S. D. Field and Mr. C. E. Fritts, in this country, and Doubrava, in Austria, called attention to the availability of condensers as direct-current transformers, at a time when the alternate-current transformer was fast occupying a field which it has now made peculiarly its own. But while thus early recognized in connection with direct-current distribution, recent developments indicate unmistakably that associated with alternate current distribution the condenser will find its more immediate and perhaps extended application. In view of this, the discussion of the condenser as a transformer of electric energy is eminently timely, and we therefore give the conclusions arrived at by Mr. Jas. Swinburne in an analysis of the subject. But besides their employment as pure converters, the important functions which they perform in alternating-current apparatus involving a lag of phase, such as we meet in the new types of alternating motors, give them an immediate interest of the highest order. If to this we add the possibility hinted at of obtaining the direct currents necessary for energizing the field magnets of alternating machines by means of condensers, and without a commutator, then indeed it must be admitted that the condenser is worthy of the most serious consideration. Nor must we forget the important part it is destined to play in the beautiful and almost ideal method of illumination of Mr. Tesla, whose experiments as detailed in his now famous lecture before the American Institute of Electrical Engineers show some of the difficulties met with in employing condensers at high potentials and frequencies. In this respect the condenser transformer will, without doubt, be made to conform to the most recent practice adopted in connection with the iron transformer, in that air will no longer be used as the insulating material, giving place in its stead, to oil. The cost of condenser apparatus for the various purposes alluded to, will to a certain extent be governed by the potentials employed, as this will determine their size, but the advantages which the use of the condenser will bring with it will probably offset this consideration in a large measure.

LOW-TENSION ALTERNATING CURRENTS FOR ISOLATED LIGHTING.

One of the earliest methods employed for isolated lighting purposes was the operation of low-tension alternating-current machines, a type which was adopted at the time principally for the reason that the machines were simple in construction and were claimed to give very good regulation. Our readers will remember that among those machines, the Ferranti-Thomson obtained considerable prominence about ten years ago. At present, however, this method machine is used for low tension. That there appears to be has been entirely discarded, and the continuous-current good reason for seriously reconsidering this method at the present time was, we think, well brought out in the interesting article by Mr. Horry appearing in our last issue. Mr. Horry, in fact, advocates the adoption of the low-tension alternating machine for isolated lighting, especially in view of the fact that we have now placed at our disposal a simple way of regulating the intensity of illumination in the lamps by means of a device which consumes no energy. While there may be those who doubt the value of this particular quality in a lamp installation, there can be no question as to the simplicity of the alternating machine and its excellent regulating qualities.

ELECTRICAL FAKES AND FRAUDS.

The paper by Mr. A. A. Knudson read by him before the New York Electrical Society last week, on frauds in the electrical business, touched an amusing and interesting subject that, as far as we are aware, had never before been handled at a gathering of the kind. The pity is that it is not possible to reach a larger audience or body of readers with it than is the case, where all to whom it is addressed are familiar with the questions involved and are not likely to suffer from imposition. Mr. Knudson makes an exposé for instance of the Scott electric hair brush ; but we take it for granted that no electrician or electrical engineer uses Scott's brushes or the other fellows' belts or any other swindles of that character. As to what may be termed "frauds," namely, attempts to plunder the public through the medium of new "inventions" of alleged merit and value, it is evident that in this respect also the desideratum is to get the ear of outsiders. No electrical engineer loses his money in such a fraud as the Friend electric sugar refining, but a good many of us know people who are prejudiced against electricity because they have been big enough fools to invest without investigating. There are remedies against these fakes and frauds, and it becomes the duty of every informed man to make an exposé of such deceit wherever and whenever he encounters it, either through the ever-open columns of the scientific press, or better yet, with the help of such useful functionaries as district attorneys and such bodies as the grand jury. It is, perhaps, significant that Mr. Knudson's paper was read at Columbia College. It is to the influence of our seats of learning and of the educated men they turn out that we must look for the greatest protection and advance. A large number of people like to be humbugged and need no sympathy with their peculiar manifestation of weakness of mind ; but not a few other people suffer sorely in mind, body and estate from these predatory swindlers, who take advantage of the popular belief in the ability of electricity to do anything and everything.

Cheap Street Railway Track.

It would certainly seem as if the most limited amount of common sense might by this time have taught our horse railway managers the unprofitableness of making use of the most costly kind of motive power for no better purpose than that of banging their cars to pieces against the unevennesses of a weak and flimsy track. Yet one may see to-day a new track in process of being laid in West street in this city—a location in which, to say nothing of the heavy legitimate wear, it is subjected to the incessant pounding of a never-ending procession of heavy freight trucks—in which the superstructure consists of a light side-bearing rail spiked upon longitudinal wooden stringers.

Iron in Central Station Construction.

Mr. A. E. Braddell writes us this week with regard to a point of special interest in central station construction, namely, the use of iron particularly in roofs. He states that some of the stations he has visited as an insurance inspector have suffered from the dropping of moisture from their iron roofs like a heavy dew, creating a condition of danger in the short-circuiting of the apparatus, etc. Two remedies suggest themselves. One is the construction of an inner roof of wood immediately under the iron ; the other is the erection of slight sheds or awnings just over the engines and dynamos. Further and better remedies than these should lie within reach, and we shall be glad to hear from our readers on the subject. Iron is pre-eminently a material to employ in central station construction, with brick and stone, and we are slow to believe that solid or lasting objection can be found in the troubles to which Mr. Braddell calls attention.

What Shall We Do with Our Mules?

The mule is not a thing of beauty, although his efficiency is very high, and his capacity great, and when his field of labor in the lower walks of life is suddenly closed to him his usefulness is gone. When electricity usurped the place of animal power on street railways, an opportunity was afforded the horse to turn his attention to nobler things, but when canal boats are towed, and plows driven, electrically, as described recently in our pages, the mule suffers, while his manufacturers are fain to go into the motor business.

NOTES ON ELECTRIC STREET RAILWAY CONSTRUCTION.—I.

BY

A. K. McCay.

WHEN electric railroads were first introduced, the methods of different systems were quite at variance. There has been very generally, of late, a weeding out of the older and cruder methods, and nearly all systems have adopted, more or less, the good points of their rivals. So that to-day there is a similarity, and, in fact, nearly an identity, in the best railroad practice.

Beginning with the generating station, we will endeavor to refer briefly to some salient points of construction and arrangement of a successful railroad plant. If the road is to be a small one, say under ten miles, a high speed, quick-governing engine is to be preferred; as the load is very likely to vary from zero up to full load in a few moments. The engine which is generally recommended is one that has fly-wheels especially heavy, and an automatic governor sufficiently sensitive, so that variations of load are quickly compensated for. The best practice strongly recommends the use of a simple engine where condensing is not used. If water be convenient and cheap the first cost of compounding and condensing is far outweighed by the saving in coal, very often amounting to 25 per cent. In larger plants some form of Corliss engine is very generally adopted, although the writer infinitely prefers a triple or even quadruple expansion engine directly geared to the dynamo. This latter engine, usually of a vertical type, is being rapidly introduced on ocean steamers, where economy of coal means economy of operation, just as it does in an electric light or railway plant. The latest tests of this type of engine in England give a little over 1 lb. of coal per horse-power hour, so that no doubt the large railroad installations of the future will seriously consider such an engine before introducing one less economical.

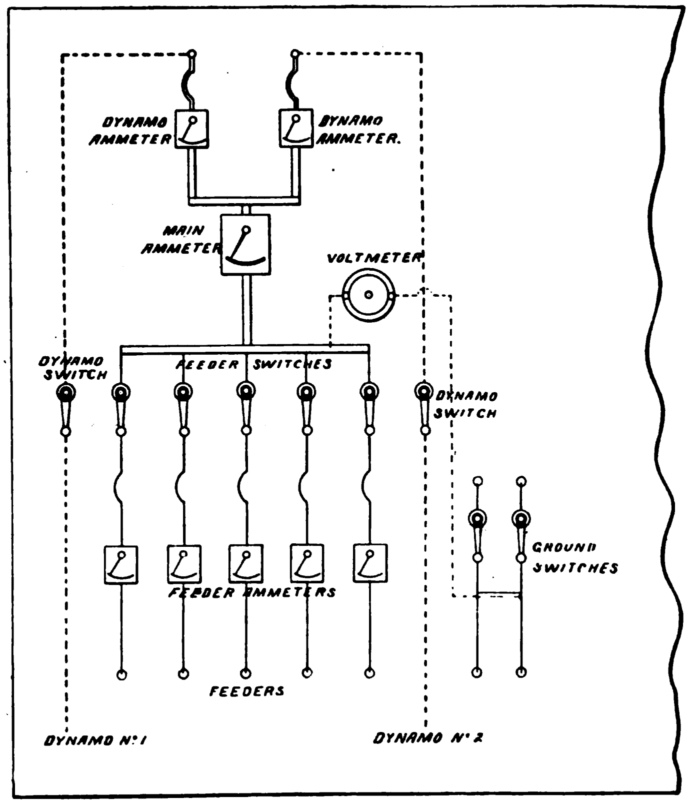


FIG. 1.—SWITCHBOARD FOR ELECTRIC RAILWAYS.

As to the dynamo, general practice has evolved a very efficient machine of the compound type, whose voltage is practically constant, and whose life is only measured by the care bestowed on it. The writer was in a large railroad plant a short while ago, and saw dynamos which have been running some eighteen months, and which are at rest just *forty-five minutes* each day, and yet the commutators were as bright, and just as large in diameter as when they began running. The application of the carbon brush practically extends the life of the dynamo indefinitely, if not heavily overloaded.

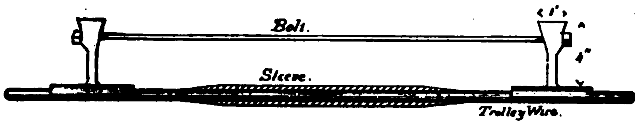


FIG. 2.—METHOD OF RELIEVING STRAIN ON TROLLEY WIRE JOINT.

Passing from the machine to the switchboard, we would recommend this to be of slate, set well away from the wall, at least four feet; and so placed as to be easy of access and perfectly safe from fire. In small stations the solid brick wall may be used; small, neat strips of wood being nailed to the wall, on which the bus bars and instruments may be secured by porcelain insulators. Fig. 1 shows the general type of a board for two dynamos. It will be noticed the main ampere meter registers the joint load when both machines are running, and checks the reading of each dynamo ampere-meter when running alone. On each feeder there is placed a fuse, a switch and an ampere-meter, so that an account can be kept of the amount of horse power required for a certain route. The wires should be brought under the floor in conduits to the switchboard and be brought from the back out to the front of the board. On installing, the board should be sufficiently large, so that additional dynamos may be connected as the business grows, as grow it will.

Passing from the switchboard to the line, we will first notice the poles. If these are of wood they should be at least 25 feet long and 7 inches in diameter at the top, and either of cedar or chestnut. In setting the poles great care should be exercised. The holes in soft dirt should never be less than six feet, while in rock formation five is permitted. Before being placed in the hole, the lower end of the pole should be coated with tar, as this will be found to materially lengthen the life of the pole. Great care should be used in setting poles. The bottom should be braced with heavy stones thrown into the hole and well rammed. The poles on a 30-foot street (between curbs) should rake some 9 inches away from the centre of the street; on a 50-foot street 14 inches will not be found too much. Special attention should be given to corner and end poles. The heaviest and stoutest poles should be chosen for these positions, and from 2 to 6 inches additional rake should be given them. Too great care cannot be given to ramming and setting

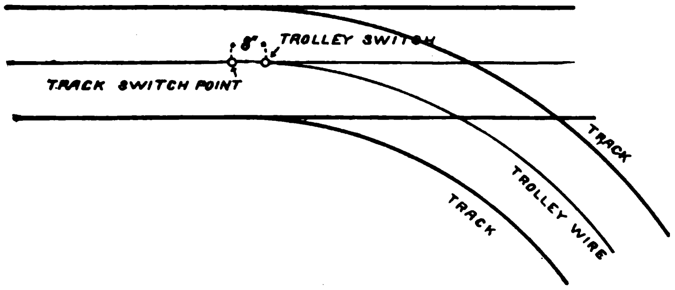


FIG. 3.—LINE CONSTRUCTION AT SWITCHES AND CURVES.

these important poles, as the life of the line and the efficiency of the service will greatly depend on this portion of the work being well done. Iron and steel poles are not given so much rake as wooden ones, because they are stiffer, and their bases are practically immovable. In setting these, care should be taken to see the concrete well rammed and that it is fresh and not set before being put around the pole.

When the poles are well set, the span wire should be strung. Modern practice is rapidly discarding the ratchet for the turnbuckle, which, to the writer's mind, is a very sensible move. Larger wire is also being used; some advocate ⅜ inch diameter, which, while to my mind it is excessive, is certainly safe. The trolley wire will probably give no trouble except at the joints. The constant passing over of the joint by the trolley wheel seems to crystallize the solder and render it brittle. If the line is stretched taut, the cool nights of the fall and early winter contract the wire, and bring a great strain on the joints, causing the wire to break at these points, entailing delay and sometimes accident. The writer has used with good effect a device shown in Fig. 2 to prevent this; and, in fact, partially to relieve the joint. It consists of two pieces of brass, whose lower part is cast to receive the trolley wire, like a bell hanger; but whose upper part is heavy enough to have a ½-inch bolt pass through it. This bolt is usually some 16 inches long and extends from one brass piece to the other; both being soldered to the trolley on each side of the sleeve. This bolt takes the strain somewhat off the sleeve, and has been found to practically overcome the trouble of the trolley pulling loose at the sleeve.

Line switches can give a great deal of trouble if not properly placed in reference to the track switch. Fig. 3 shows the relative position and the distance between the point directly below the line switch, and the point of the track switch is given as 8 inches, a distance which has been found to give excellent results. At this distance the car is well around the curve before the trolley wheel reaches the line switch. This causes the trolley wheel to bear well over in the direction the car is taking, and the trolley wheel takes the switch without fail. With these points well adhered to, little trouble and minimum expense will be found in the operation of these branches of an electric street railway plant.

A SIMPLE HELIX TELEPHONE RECEIVER.

BY

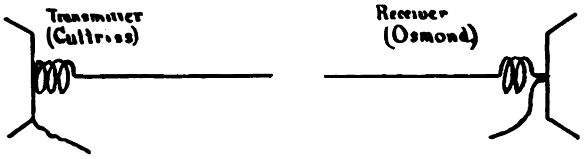
J. Thornton Osmond

MR. CUTTRISS described, in THE ELECTRICAL ENGINEER of Dec. 16, 1891, a telephone transmitter of decidedly novel and very simple construction, and possessing superior qualities as a transmitter. I would like to call attention to a point concerning its action which he appears to have overlooked, and also to describe a very simple and mechanically similar receiver which I made in 1886, and found to have superior articulation.

In his description, Mr. Cuttriss speaks as though he regarded the action as due wholly to the change of resistance of carbon with change of pressure. I think that there is another principle which, if secondary to that named, is important in the action. I refer to the electro-dynamic action of currents in neighboring conductors. When the slight increase in pressure due to a vibration of the plate causes an instantaneous increase of current, this increasing current in the coils draws them together and thus adds to the pressure and so to the current strength. This electro-dynamic action will contribute largely to the strength of the whole action.

Perhaps I should not attach so much importance to this point but for the following experiments: In 1885, in trying to form a system for classifying telephones, it occurred to me that among the various principles of electrical action which might be used to convert the energy of the current into mechanical vibrations of similar "form," the electro-dynamic action of currents, as in a helix, had not been used. It seemed to me doubtful whether the electro-dynamic action could control the natural periodicity of the helix, and its inertia.

To test this, I made, in the early part of 1886, a rude apparatus of a bored block of hard wood, clamping a tin-type diaphragm with one end of a helix soldered to the centre. The wire was bent sharply back and then off at a right angle, as shown in the illustration. The transmitter used was sometimes the Bell (Berliner-Blake), and sometimes the Reis "bored block." It required a good deal of trial, different springs, tension, etc., to get articulate speech. Sound and pitch gave no trouble at all. But occasionally, when everything was just right, words were received with great clearness and strength.



THE HELIX AS RECEIVER AND TRANSMITTER.

Of course, both Mr. Cuttriss' helix and mine, when a current passes, form magnetic fields varying with the current and acting on the diaphragm. But I found that it was possible to connect the end of the helix to the diaphragm by six or eight centimetres of silk thread without material change in the action. The proof seemed to me complete that electro-dynamic action of currents could be applied, as in a helix, for the telephonic receiver.

THE BERLINER PATENT AND THE HUNNING TRANSMITTER.

BY

Albert Stetson

THE granting of Berliner's patent of November 17, 1891, seems to have called out a great deal of discussion and the expression of a variety of opinions. Some have maintained that its granting after so long an interval was an injustice, and one that would be remedied by the courts. To the writer there seems no injustice, in fact it seems entirely in accordance with the rules of the Patent Office, and its being kept in the office appears the only possible way of keeping within the spirit of our patent law. If the patent is so basic as is claimed, a great injustice would have been done by its issuance previous to the final decision by the Supreme Court on the telephone cases. Drawbaugh claimed to be the original inventor of the telephone, and while his claim was unadjudicated, it would not have been right to issue so broad a patent. How just the action of the office was, is shown by the fact that three out of seven of the Supreme Court judges were disposed to recognize Drawbaugh's claims. Whether the patent to Berliner should have been kept in the office from that time until its issue, is a question better decided inside the Patent Office than out. At all events the Commissioner seems to deserve great credit for getting it out of the office so soon after entering upon his new duties.

If it is wrong, as is urged, for patents to remain tied up so long in interference proceedings, then the remedy is not growling over specific cases, but an earnest attempt to reform some portions of our generally admirable patent laws. This would have to be done through an act of Congress, and the real friends of our patent laws would shrink from attempting any reform from fear that in reforming one pillar of the building we may pull the edifice down upon us.

Some claim that there are certain foreign patents issued to Berliner which will limit the life of his American claims to a very short period, if they have not already expired. This may be so, and in the absence of an extended search, it is impossible to say how much weight should be given to this objection. That will be a question for the courts to decide. In the absence, however, of any such test, it is well for those who expect on the expiration of the Bell patents, to reap fortunes in the telephone business to let their feet be guided somewhat by the lamp of experience.

In view of the magnificent business management that has characterized the commercial and legal conduct of the Bell Company's affairs, the idea would naturally suggest itself that the attorneys of the Bell Company were as well aware of the existence of the alleged foreign patents as any outsider could be. Looking back over the past records it will be difficult to find any great number of instances in which Mr. Storrow has been caught asleep. Many a time opposing counsel have found him very much awake, really too much so, and their clients' pocketbooks (if opposition telephone companies ever paid their bills) have suffered severely from their error of judgment as to the ease with which the Bell monopoly could be overthrown. Before venturing too far, and expending too much money, would-be telephone investors will do well to carefully examine the alleged defences.

To the writer the easiest, and apparently only safe, attack upon the telephone field, after March 7, 1893, seems to be through the Hunning patent, No. 246,512, of Aug. 30, 1881. This patent having been taken out in England on Sept. 16, 1878, will become public property on Sept. 16, 1892, and it would seem that any one will then be free to use "carbon in a state of fine loose powder, not in any way compressed or consolidated." I cannot think the Berliner patent will be possibly interpreted broadly enough to cover this use of carbon. As to the efficiency of the Hunning transmitter, Preece & Maier, in their book, "The Telephone" (page 88) say, of transmitters of this class: "It was certainly the most powerful instrument tried in England." The so-called long-distance instrument of the Bell Company is based upon the use of carbon in a free and loose state, and all know the excellence of that apparatus. With respect to the patented improvements embraced in that instrument, there are likely to be some interesting developments in the near future.

With such reliable instruments in the hands of the public as the Hunning transmitter and the Bell receiver, it would seem to be a matter of indifference whether the last Berliner patent were sustained or not.

MAGNETIC PROPERTIES OF LIQUID OXYGEN.

PROF. DEWAR recently made a highly interesting communication to the Royal Society. He sought to determine what effect a temperature of 180°C. would have upon the behavior of liquid oxygen in the magnetic field. Having previously ascertained that liquid oxygen does not moisten or adhere to rock crystal, and consequently maintains in contact with that substance a perfect spheroidal condition, he poured the liquefied gas into a shallow saucer of rock crystal, and placed it between the poles of the Faraday electromagnet. On the magnet being excited, the whole mass of liquid adhered to the poles until dissipated.

FRAUDS IN THE ELECTRICAL BUSINESS.[1]

BY A. A. KNUDSON.

THIS subject unfortunately is one of such wide scope that to cover it fully would mean the publication of a good-sized volume. For a paper of the ordinary length therefore I shall only touch upon the various branches of electricity in which impostors have left their tracks, and relate a few instances as they have come under my notice during the past few years, which will show some of their methods. We wish it understood that in speaking of impostors or "fakirs" in this paper we mean only those who, knowing an invention to be worthless, or of but little value, will attempt by false statements to induce people to put money into the same. Neither do we wish to include under this head those inventors who, honestly believing they have discovered something new and original, seek to interest capital, although their scheme may finally prove to be impracticable or previously patented.

We will now consider one or two fakir methods in the galvanic or storage battery line which as we all know has proved in the past an inviting field for that class of men. The first will be the primary battery with the electric motor. Some years ago before the advent of the dynamo, when electric motors had to depend upon the primary battery for current, a French gentleman appeared in New York with alleged new and useful improvements in both battery and motor. He had induced a relative of mine (since deceased) who was an officer in one of the savings banks to invest in the same, and had been given the use of an unoccupied room above the bank for the purpose of exhibiting the apparatus. I was asked to call and examine this "wonderful invention," for, according to the inventor, it *was* one of the greatest scientific productions of the day. The motor did not differ in principle from those already invented and published, such as that of M. Froment or of Davenport on this side of the water. In fact it was not only the same in principle as that of Froment's but nearly the same in construction.

The battery, the inventor said, was a secret, and he would not explain it. The method of demonstrating the efficiency of both motor and battery was by lifting a weight of a few pounds to the ceiling by means of a pulley and rope, the rope being wound around a drum secured to the shaft of the motor. The battery although a secret, disclosed itself soon after the motor was started, in the strong nitric acid fumes it gave out, and the active manner in which it boiled. When spoken to about the strong odor from the battery which was enough to choke one, the explanation would generally be (with an attempt to smell): "You smell anything?" Our report as you will surmise, was not favorable and we strongly warned the banker to go no further, but he had actually become so wedded to the scheme that he would believe nothing against it and all I got for my pains was a self-satisfied smile and the remark, "Well, I can believe my own eyes when I see that weight going up to the ceiling."

You will anticipate the outcome. I left them to themselves and to their own eyes; and after several thousand dollars had been sunk in the attempt to make the scheme practical, it was finally abandoned. The banker frankly acknowledged afterwards that he believed the whole thing was gotten up with the deliberate intention to deceive. So much for that wonderful motor, and the battery that was a secret.

Another case, and this will illustrate how people will sometimes put their money into a scheme, and afterwards seek advice in regard to it, was one which came under my notice a few years ago where the primary battery played a conspicuous part (although concealed in the cellar), and was, like the one in the previous case, a secret. It had for its object the production of an electric light. The gentleman who employed me to investigate this case, had, I was informed, already invested something like $20,000 in the scheme. Knowing this I certainly expected to find something at least worthy of an invention. It is a singular fact, however, and one that I have often come across, that instead of getting full and reliable advice before embarking in a venture, people will often invest their money and then afterwards, when a sense of doubt and insecurity dawns upon them, will fly to an expert.

The object of this invention, as already stated, was the production of an electric light. It was exhibited in a room ordinarily used as a dining-room in a private house. There were three or four lights placed on the chandelier and when the current was turned on, they did make a brilliant and steady light while it was being shown. It consisted of two small carbon rods placed inside a glass tube, the point of contact between the carbons being about midway between the ends of the tube which was about six inches long with a bulb at the centre. The wire from the battery connected with the carbons, and that was practically all there was to the invention. The inventor succeeded even before any patents were obtained, with his exceeding plausibility (and he was a remarkably good talker) in inducing these gentlemen to put in this large sum of money. Why, to hear this man talk was enough to deceive the very elect if they were not posted, and to show how easy some men are induced to invest in worthless enterprises of an electrical nature when in the hands of a good talker, I will give an example of the way he talked—"Edison was nowhere. For years Edison had been trying to accomplish what he had already just perfected. In Edison's system enormous capital was required in the construction of central stations, besides the cost of running expenses for fuel, labor, etc.; but in his system all of this was done away with, and for a few cents per night a whole house or store could be illuminated, and the battery would run indefinitely," and so on, ad infinitum. All of this time he was careful to conceal the fact that he was using in the battery in the cellar electropoion fluid by the barrel and zinc by the square yard in order to produce the three or four lights for comparatively short intervals of time. He told the gentlemen present and myself that there were but four cells of battery in circuit; this to me was surprising for the amount of illumination given. By a series of cross-questions we finally found out just what he had. The four cells of battery consisted of four enormous earthenware crocks, holding about 25 gallons each. Across the top of each jar or crock was placed a bar of wood to which was secured various plates of carbon and zinc running down to the bottom of the jar, so that instead of four cells or galvanic pairs in circuit, there were actually nearer 40 of very large size and the beautiful and brilliant electric light on the chandelier was duly accounted for. I do not suppose that the gentlemen who had invested their money in this scheme thought it worth while to even inquire about the battery. They saw the light, and like the banker in the former case, when he saw the weight go up and heard the inventor talk, they thought they could believe their own eyes. After the exposure was made, there was no more money invested in that scheme.

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[1] A paper read before the New York Electrical Society, Dec. 30, 1891, at Columbia College.

I could give many other instances where the impostor has manipulated the galvanic battery to his own profit; but as they would be almost repetitions of those just stated, we will pass on and look into some of the fakir's work in the electric and acoustic telephone business. I presume there is no electrical business of late years which has been so thoroughly worked by unprincipled men as the telephone business, and in order to have a better understanding of the methods of telephone sharpers, we will give a short résumé of the telephone situation as we understood it a few years ago. Where important lawsuits have been going on, the amount of fraud occasionally practiced in the attempt of one company to secure an advantage over another, would, if made known, be surprising. Bribery and false swearing has often been resorted to in some of the telephone patent suits in past years. Witnesses, experts, lawyers, and even the judge on the bench have not been entirely free from the baneful influence. I will give an instance: You may have heard of the man who was an examiner in the electrical department of the Patent Office at the time the Bell patent was issued, and who in later years for a certain sum of money made an affidavit in favor of the Bell Company setting forth certain alleged facts which occurred at that time, and who not long afterward accepted a fee from another company and made another affidavit setting forth alleged facts entirely contrary to the first sworn to. It often happens in patent suits where large amounts of money are involved, the temptation is strong to mislead and deceive, wherever such deception will be of advantage. Especially was this the case in the legal telephone fight during the attemps made to overthrow the Bell patent by attempting to show that the Reis telephone would articulate. It was well known that if the telephone invented by Reis in Germany (which ante-dated the Bell by several years) could be proved to have talked, and to have actually produced articulate as well as musical sounds, it would mean death to the Bell patent. Or if a telephone made exactly on the principle of the Reis could be shown to articulate in court, if only for five minutes, it would in all probability upset the Bell patent, the advantages of which would thus revert to public use. Hence there was abundant reason for the opponents of the Bell Company to prove if possible one thing or the other, and the utmost exertions were put forth. Germany was ransacked for relatives and those who had been acquainted with Reis during his lifetime, and affidavits and witnesses were obtained by the score, attempting to prove when, where, and how the Reis telephone talked; without doubt many of these affidavits were drawn from mistaken imaginations, while others were but partial truth. On this side of the water numbers of inventors were at work struggling for the prize in their efforts to make the thing articulate. I well remember the experience Mr. Mailloux and myself had in that direction. Night after night we worked at our homes in Brooklyn with varying success. Sometimes we would succeed in making it articulate, but our experience was, it seemed impossible to make it stay in that condition. We finally came to the conclusion that it was possible to make a Reis telephone talk, but it could not be depended upon to stay in a talking condition from one minute to another, and so far as my knowledge extends of this subject no telephone made exactly after a Reis pattern has ever been able to articulate for any length of time. When they did articulate it was probably on account of either an extremely delicate adjustment which was only temporary, or the oxidation of the contact points, thus for the time creating the variable resistance which is the life of articulation. But we could not trust it to remain in that condition over night; often did we lay it carefully one side after working for hours at night, feeling, that at last we had it, and in the morning find it as dumb as an oyster, and finally we abandoned the attempt entirely.

There was one party, however (and this is more in line with my subject in speaking of frauds) who claimed to have produced a constant talking Reis telephone, and to the consternation of the Bell Company actually showed it in a good talking condition; there could be no fault found with the articulation; it did talk and talk well, and things for a time looked blue on the Bell side of the house, until one of their experts, more observing than others, discovered a carbon button concealed in the box and in the circuit, so that it was not a genuine Reis telephone that produced the articulation, but one with the necessary modern improvement.

I once had a telephone case to investigate which will show to what extent a fake scheme will sometimes go before it finally reaches its end. There were but two papers furnished me to examine, one a copy of the patent (there was but one patent), and the other a copy of the prospectus. The claims of the patent were exceedingly limited, but the prospectus was broad enough to make up for any deficit in that respect. One clause in the patent set forth that this invention was based on the undulatory current principle, while a clause in the prospectus stated that the invention was not based upon the undulatory current theory but upon the make-and-break principle—a square contradiction on its face.

In point of fact it did not differ only in construction to the Bell telephone. The parties to whom I reported did not invest in the scheme, but other parties did, and a company was started. Their method of doing business was to manufacture the telephones here in New York, sell State rights on the patent, and establish local companies in cities and towns wherever they could, and supply them with telephones. In this way they earned in course of time sufficient money to pay a dividend on the stock and the stock advanced (a good deal of it being sold) and everything went on swimmingly; about this time I was asked by the party for whom I reported if I had not made a mistake, and they pointed to the fact that a dividend had been paid by this company. I said I thought not and advised them to wait a little longer. The Bell Company through the slow process of the courts finally reached them, and they were blotted out of existence.

A similar experience as we all know happened to a large number of other companies who attempted to compete with the Bell Company. In the acoustic telephone business it seemed at one time as though it was infested with fakirs. There seemed to be stronger inducements in the acoustic field for this class of people even, than in the electric, especially after the Bell patents had been sustained by the courts. I presume one reason was, there was no difficulty in convincing people that there was no infringement on the Bell patent, it being easy to show no electricity was used to carry the voice, and another reason was that an acoustic telephone when first put up for exhibition purposes generally worked surprisingly well. The voice could usually be heard from 10 to 20 feet away from the instrument, and the promoter would not be slow to exaggerate these advantages and almost always to characterize it as fully as important and valuable as the Bell telephone. They would say nothing about the difficulty of constructing the wire and of keeping it in repair, and in most cases those investing would hardly inquire if there were any wire at all, when in point of fact the wire is the most important part of the whole business of an acoustic telephone line. The difficulty of maintaining it is well known. In this respect this case would be similar to those above mentioned where people saw a weight go up, and saw a beautiful electric light. They thought they could believe their own eyes and when some people listened to the remarkable performances of the acoustic telephone they thought they could believe their own ears. The acoustic telephone has its place in the commercial world and in its place is most useful and convenient; but in the past it has been badly misrepresented by being exaggerated by men whose only ambition was to sell stock in fake companies

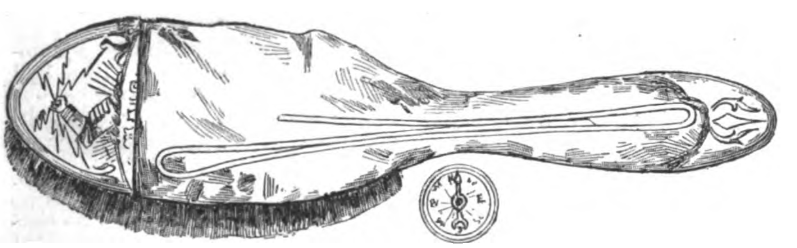
We will now leave the telephone business and pass on to the consideration of telegraph frauds. Some years ago a French Canadian appeared in Hartford, Conn., making a great stir about a new multiple telegraph system which he claimed to have invented. According to his story he could send and receive upwards of 40 messages over one wire. The duplex and quadruplex were but child's play in comparison, and so plausible were his other assertions concerning it that he succeeded in interesting some parties and finally obtaining from them a considerable sum of money for an interest in the scheme.

For a complete swindle in every detail this beat all I have ever heard of in the electrical business. It was an ingenious swindle and in order to describe it more fully I will refer to the diagram on the blackboard. A few instruments only are shown but they will be sufficient to illustrate the scheme. Several Morse sets of instruments were placed at each end of a room and a wire loop was run to New Haven, in which wire the main battery was placed. From the ends of this loop, wires were branched to one of the two binding-posts of the instruments; from the other binding-post ran a wire to all appearances to the ground, but it did not go there at all for it was purposely broken inside of the insulating covering and the ends pulled apart. Another very fine wire, however, was connected to the bottom of this same binding-post at each instrument, carefully concealed, and led to the side of the room where it was hidden entirely from view behind the paper on the wall. These fine wires all connected with the opposite instruments in their respective pair at the other end of the room. The wire in the long loop to New Haven, as you will observe, simply acted as a return ground, or one side of a metallic circuit. Under such conditions the multiple scheme, as you would expect, worked perfectly, and with any number of instruments. After the inventor had absconded with his money, which he did shortly after he got it, the instruments were removed from the room, and in doing so the fraud was discovered, for there were the wires all carefully concealed behind the wall paper.

Electrical frauds have visited the United States and plied their vocation from most every country on the face of the earth, but this man was from Canada, a country one would hardly expect to produce such a clever electrical swindler, and he showed a surprising nerve by going right into the heart of Yankeedom, in the State of Connecticut, where the people's reputation for shrewdness is so well known that it has been said, in order to dispose of some of their products such as wooden nutmegs, etc., they are compelled to go outside of the State to do it. During my sojourn in Canada for the past four years I have met but one or two who could be termed electrical fakes and they came from the States. Another phase of electrical frauds may be illustrated in a recent exhibition of a scheme in Boston.

The inventor showed a battery of peculiar construction; to the zinc pole of which was attached a wire leading out of doors to a lightning rod a short distance away. The wire from the other pole of the battery went somewhere, but supposedly to go to the ground.

The object of the scheme, according to the inventor, was to produce a constant and unlimited supply of electricity from the air. To show the practicability of the scheme a motor was placed in circuit and it ran as though it would burst; an ordinary Morse sounder was tried and that worked as though it would be torn to pieces. Mr. Frank Pope examined the scheme but was not allowed to look into it thoroughly and he said he couldn't tell just where the fake was, but it was there somewhere, and he advised the capitalist who was with him and who was in the electrical business to get some of his electricians to try and duplicate it if they could. I am sorry this scheme was not unearthed, for I believe it would prove an important addition to this paper.



SCOTT'S "ELECTRIC" HAIR BRUSH, WITH STEEL WIRE EXPOSED.

As a conclusion to this list of electrical fakes we will now consider the medical part of the business. Here we find among the so-called electrical appliances, such as belts, hair brushes, corsets, etc., gross imposition is practiced under the name of electricity upon the public and has been for years. There is hardly a complaint in the human calendar of diseases that these things, according to flaring advertisement and circulars, will not cure. To show to what an extent this imposition is practiced at the present day I will read an extract or two from a full-page advertisement taken from one of the most highly respectable magazines in this country:

> Disease is the result largely of depleted nerve force and demagnetized blood. These electro-magnetic corsets (the maker's name is here mentioned), belts, insoles and appliances have been demonstrated to be the best agency yet discovered for preventing this depletion and demagnetization as well as restoring such forces when lost. These garments are unlike any other device for electrifying the system or charging it with magnetism. As a force it is self-supplying, retaining its virtue for years and invariably benefits. These appliances so electrified can always be relied upon.
>
> These appliances promptly annihilate those weak and languid feelings, exterminate rheumatism from the system, and promptly cure the above-named disorders. They are light and comfortable to wear, and are guaranteed to imperceptibly generate a mild continuous current of electro-magnetism, all-healing in its effect. They differ from the so-called electric and galvanic belts which are usually worthless and which create sores on the body, leading to blood-poisoning. Beware of them and see that you get this one (our special make) with silver compass free. Ours are truly electro-magnetic, as any tyro in electric therapeutatics will inform you, and are absolutely reliable.

You will note the attempt is made here to work in magnetism as a curative property. Except where steel magnets are concealed of which I shall speak later), there is not one particle of magnetism produced by the action of a so-called electrical appliance of this class.

This is a point to which I wish to call special attention. Electricity properly controlled and applied is capable of wonderful effects in the relief and cure of a large number of diseases, and its legitimate use is increasing daily in the practice of the most enlightened and scientific practitioners of the age. In fact, hardly a practicing physician of any repute can be found who has not his medical batteries, some of them costing hundreds of dollars, with all kinds of electrodes, some of which are as ingenious in construction as they are humane in purpose.

It is just this point that the swindlers of to-day lay hold of and turn to their own purposes. They designedly confound electricity and magnetism, and by a skillful interchange of terms they encourage in the public mind the same confusion. In many cases where they claim that magnetism is generated by their appliances there is no magnetism at all; and in others where they claim that there is electricity there is magnetism. But this magnetism is not the result of any inherent virtue, it is the result of a smart piece of chicanery, in which the concealed magnet and the compass needle play the principal part. I claim, therefore, that in any event it is wrong and misleading to attempt to confound magnetism with the curative properties of electricity.

I have yet to learn the first case where magnetism, either strong or weak, has ever produced any effect either beneficial or detrimental upon the human system. Night after night for months I have been in the presence of the most powerful dynamos (as have thousands of men in the many electric light stations all over the world) where magnetism of the strongest kind permeates every bone and fibre and tissue of the body, and yet, so far as any effect either good or bad on the system goes, one would never know he had been in the magnetic field, and he would not notice it unless he found his watch stopped. To the best of my knowledge and belief there is absolutely nothing in the human anatomy that can be acted upon by a magnet. Of course, if a child swallows a mouthful of tacks or a paper of needles, there is something inside of the child upon which magnetism will act, but not otherwise.

What physician of any reputation has ever been known to attempt to apply magnetism, or to recommend the use of electric belts or the like? On the contrary every reputable physician with whom I have talked on the subject has denounced them as worthless. Let us go a little further into this subject, and see how some of these things will bear the light of an investigation. We will first consider the so-called electric hair brush. I have thought best to purchase one of these brushes so that we can just see how they are made and to prove the assertion that so far as any curative property is concerned they are no better than any ordinary hair brush. I will first read an extract or two from the directions pasted in the box in which it comes:

> Cures headache in five minutes; cures neuralgia in five minutes; restores the hair, prevents baldness. The "Odic force" can always be tested by moving the brush near a compass. This power is so strong that if the compass is placed upon a thick book or table and the brush is moved in a circle beneath the same the power will pass through the intervening table or book and cause the needle of the compass to rotate rapidly. A silver compass of considerable value accompanies each brush.

Now this brush I have does deflect the compass needle just as stated, but the real cause is very different from the ostensible one, and instead of any Odic force (whatever that may be) or any electricity having anything to do with its deflection, the statement is false, as I shall prove. I have taken pains to dissect the back of this brush and we find just what we expected to find. Embedded in the material of which it is composed is a steel magnet. That, and that alone, is the cause of the compass needle moving towards the brush when brought near it. When I purchased this brush I was told that the movement of the needle proved that the brush was charged with electricity, and I have no doubt everybody else is told the same thing that buys one. You will notice this magnet is made of a piece of steel wire in the form of a double loop and extends nearly to the end of the handle. The only electrical effect possible that can be produced by the use of this brush is static, and even under favorable conditions of the atmosphere, the greater part of such very small amount of static electricity as might be generated while the brush was being used would imperceptibly pass off the earth through the hand and arm and body of the user, leaving them no more benefited by its use than if they had used any other hair brush.

Electric corsets are another deception. How is it possible, I ask you, for such a thing to be of the slightest use electrically to the wearer when they are not even worn next the skin. The magnetizing of the steel ribs as is often done is of no use whatever as to any beneficial effect upon the wearer. Another of these precious frauds is the electric garter. I have seen advertisements, as no doubt many of you have, where the use of electric garters are guaranteed to give a more shapely form to the limbs of ladies. The absurdity of such an appliance is too apparent for comment but it is really too bad to disappoint and deceive the ladies in a case like that. What swindle under the name of electricity will not be attempted next? Why don't they get up an electrical hat band guaranteed to supply a lack of brains or furnish new ideas to those that wear them, yet would not such a thing be just as reasonable as some I have stated?

As an answer to some of the reckless statements which appear in advertisements and circulars, some of which I have mentioned, in regard to electric belts and other appliances I will quote an authority and read some extracts from De la Rive's "Treatise on Electricity." De la Rive was at the time of writing his work a member of the Academy of Sciences, and also of Medicine, of nearly every large city in Europe, so that he is an eminently qualified authority to pass judgment on these appliances. After explaining the construction of the electro-galvanic chains and belts of Golberger, and of Pulvermacher, he says:

> We do not very well understand the effect of this arrangement by virtue of which the current is scarcely to circulate in the chain without traversing, at least in a very sensible manner, some part of the body. For not even a derived current can be obtained on account of the imperfect conductibility of the skin. Moreover, no very positive fact has proved the efficacy of this later mode of application, upon which experience has not yet decided. And again, We do not deny that there may be a production of currents in these apparatus; even the galvanometer indicates their presence; but they are very feeble currents; and we do not see what advantages can be presented by these arrangements which at the very basis rest on false ideas of the electricity of contact.

My wonder is that the electrical journals have not been more outspoken in showing up these frauds upon the public. The public would naturally look to such a source for information of this kind, and these journals are not handicapped as others are by being paid for fat advertisements, for it is the uninformed public on electrical matters that they desire to reach; so they use the daily press and weekly and monthly publications to make known their wares. In summing up this whole matter of electrical appliances, it seems singular that they have been allowed to exist so long, especially the hair brush; one reason may be that the "public love to be humbugged"—but there is a limit to all things, and I predict, as electrical knowledge is being more and more disseminated by such institutions as Columbia College, it will not be long before people will understand the truth in regard to them.

Although I have touched upon but a few frauds and deceptions as practiced in the electrical business, I am aware of there being many more which would prove interesting were it not for the risk of tiring your patience. I have no doubt there are those in this audience who remember the electrical sugar refining frauds of a few years ago. Also the motors of Paine, which for many years continued to deceive people. Also much might be said of the tapping of telegraph wires leading to race courses, and the ingenious electrical devices and methods for supplying stock quotations to bucket shops in Wall street. Also some of the so-called telegraph schools, where young people are induced to pay their money with the promise of a situation as soon as competent. This class of fraud cannot be too strongly condemned.

In concluding this paper I cannot refrain from expressing a few words as to the position of the capitalist or investor in regard to new electrical inventions. In the few instances cited I have endeavored to illustrate how easy an investor may be deceived. It may be fairly asked by some, "Has the investor then no protection from the designs of a dishonest promoter, or from the mistaken though honest inventor?" I answer, he has. There are plenty of good, honest and capable engineers, in this and other cities, who, for a reasonable fee, will investigate and report upon any new scheme if they are only applied to. Some of these engineers are peculiarly fitted to give advice and opinions in certain branches of this business by reason of their long experience in such branches, while others have had experience, more or less, in all of them. Besides these individuals, there are now lately established in this city electrical firms composed of men of unquestionable reputation and standing, who make it their business to investigate and report upon any electrical invention; and I claim that there is now no excuse of an investor being deceived where such facilities exist for obtaining correct information upon electrical subjects. Would a man afflicted with disease undertake to cure himself if he knew nothing of the study of medicine, or would a man having an important lawsuit on his hands undertake the management of his own case if he knew nothing of the practice of law? On the same principle, then, an investor takes a large risk if he depends on his own judgment while placing his money in alleged new electrical enterprises. On the other hand, the judicious investment of capital in electrical enterprises has brought large returns to a great many people, and in very many cases handsome fortunes have been realized. As an evidence of this fact, we have but to point to the marvelous success of the Bell telephone, also the electric light (both arc and incandescent), also the electric railway. Besides these great industries, there is no end of less important schemes varying in value according to their commercial usefulness, and almost every day something new in the electrical line is being discovered.

In this paper I have endeavored to interest you by pointing out the methods of unprincipled people in the electrical business, and I have also attempted to make clear the importance of investors seeking good advice before placing their money in electrical schemes. If I have succeeded in these two points then the prime object of my paper is effected.

The paper was followed by a very interesting and amusing discussion, in which Prof. Crocker, Dr. Laudy, and Messrs. R. W. Pope, T. C. Martin and G. H. Guy participated. Several frauds and fakes were named, and Mr. Guy, as secretary, read a letter from one innocent who was being imposed upon by some persons advertising under the name of the society, and who recited a long list of swindles of which he had been the willing victim.

THE PROBABLE FUTURE OF CONDENSERS IN ELECTRIC LIGHTING.[1]

BY JAMES SWINBURNE.

It is always difficult to foretell the future in electrical engineering work, but it is sometimes interesting to try to see in what direction developments are like to take place.

The first idea of the use of condensers was to employ them like storage batteries, and mention is frequently made by the early electric light patentees of their proposed use in this way. It is needless to remark that these inventors had not the most remote idea of the vast electrostatic capacities needed for storing by the hundred ampere hours.

The project of using condensers instead of transformers is by no means dead. It has been recently taken up on scientific principles by Mr. Doubrava. As soon as a condenser is charged and discharged rapidly enough its size becomes manageable, and Mr. Doubrava is therefore working out a system in which condensers take the place of converters. This development is in good hands, and need not be discussed further. One great difficulty is in charging condensers with direct currents. A condenser of the capacity of a farad charged with one volt contains, if the expression be allowed, only half a joule. If a condenser is charged by being connected to leads at one volt half a joule is wasted over resistance and the other half is stored. The only way of charging the condenser without loss is to connect it with an electromotive force which is gradually rising. Similarly, in discharging, the electromotive force must fall gradually. This condition is not at all difficult to attain.

The greatest development of the use of condensers will probably be in connection with alternating currents. It is doubtful whether ingenuity will ever design an arrangement of condensers that will take the place of transformers in practice. In one sense there is better material to work upon. A transformer is always inefficient on account of hysteresis. The loss by "soaking in" may be taken as analogous to the loss by hysteresis, but it is infinitely less in comparison. For instance, a condenser that takes 2,000 volts and 10 amperes has a loss which is too low to measure—that is to say, it is less than 5 or 10 watts. This loss is proportional to the size of the condenser, so that small sizes are just as efficient as large. In transformers this is not the case. A 100,000 watt transformer has a loss of from somewhat less than 1,000 up to about 5,000 watts, according to the design, and if the 100,000 watts is made up of a number of small transformers the loss is much greater.

The uses for condensers are already developing. In the first place, they can be used to supply magnetizing or exciting currents to all sorts of machinery, and also to apparatus that takes lagging currents. It must be remembered that the magnetizing current in any receiving apparatus means a demagnetizing current in the generator. As an example that will soon be common, and is also striking, we may take that of running arc lamps off 100-volt circuits with choking coils in series with them. As far as the lamp is concerned, there is no better arrangement than running it off a 100-volt circuit with a choking coil in series with it to reduce the terminal pressure to about 30 volts. If such a lamp takes 10 amperes, the apparent power taken is 1,000 watts, but the real power is probably less than 300 watts. The dynamos at the station have thus to supply large "idle" currents. These not only lead to armature heating, but also demand extra excitation. If many arc lamps are used, more dynamos become necessary, as no machines will stand three times their normal armature currents, even though they are out of step with the electromotive forces. Such currents, therefore, lessen the plant output, or, as it is often loosely called, the "plant efficiency." To overcome this trouble all that is necessary is to place condensers in shunt to the choking coils and lamps, or in shunt to the high-pressure leads. The last arrangement is best, as it admits of arranging the condensers at the central station. In addition to this, condensers for 2,000 or 1,000 volts are easier to make than those for 100 volts. Condensers for such low pressures cost too much in tinfoil, and are somewhat bulky, because the dielectric has to be made thick in proportion, to make certain of the absence of flaws. At present comparatively few arc lamps are run in this manner, but that is because nearly all the alternating current systems now in use have small transformers in houses and high-pressure mains about the streets. It is probable arc lights will be run off 100-volt circuits with choking coils, and condensers will be required at the stations. Of course there is no reason why arc lights should not be run off high-pressure circuits by means of constant-current transformers. This system has never come into use in this country, probably because the low cost of this method is not generally appreciated.

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[1] Abstract from *Industries*.

It may be well to give some idea of the size of a condenser. One cubic foot of condenser will take about 2,000 volts and 5 amperes, or 10,000 apparent watts. With higher pressures the volume necessary is slightly less, and with low pressures the size increases. Below about 500 volts the bulk increases rapidly, as the volume of tinfoil is greater. The cost, therefore, increases too. It is possible to make condensers very much smaller than this; but while they are new it is best to allow a large factor of safety. Choking coils and constant-current transformers for arc lamps are not the only things requiring exciting currents. Transformers, especially if made with open iron circuits, take "idle" currents, and this can be supplied in the same way. Nearly the whole of an open circuit exciting current can be supplied by condensers. There is always some left over, because the electromotive force never varies exactly harmonically. Even if it did, there is some loss in the iron, so the no-load current cannot be reduced to nothing. In a closed circuit transformer the no-load current is less to begin with, but the active component is much greater, so that it cannot be reduced so much by condensers. It can generally be about halved.

The next use, which is analogous to those already described, is in connection with motors. Of course it is a little difficult to say what the alternate current motor of the future will be like. If it is a synchronizing machine, with the magnets excited by a direct current, it may take a leading or a lagging current, or one in step with the pressure. If it has field magnets excited by an alternate current it will take a lagging current, and condensers will be necessary. Nearly all the multiple-current motors take large exciting currents, so condensers will be necessary in their case. Take the case, for instance, of the Dobrowolsky 2 h. p. motor, as it is the only case whose figures have been published: at no load it takes 70 volts and 30 amperes at 35 periods per second. This current is presumably in each of the circuits, so that the apparent power is 4,200 watts; at full load it takes 70 volts and 100 amperes in each circuit, or 14,000 apparent watts. It, therefore, requires two condensers to reduce the apparent watts to about a tenth of these values. The enormous exciting current taken by this form of motor is one of its greatest disadvantages. A condenser to supply 14,000 apparent watts at a frequency of 35 would have a volume of four cubic feet. If the frequency is raised to 100 the exciting current increases at approximately the same rate, and so the condenser remains the same size. As there is some difficulty in making large low-pressure condensers, it is best from that point of view to put the condenser on the high-pressure side of the transformer. This, unfortunately, demands that the transformer should be 10 times the size. Thus, a 2 h. p. motor of this type would demand a 20 h. p. transformer at a frequency of 35, or a 60 h. p. at 100 periods per second. The transformers are nearly the same size in these two cases. The enormous size of the transformer is a great drawback to machines excited by alternate currents, and, unless multiple-current motors can be greatly improved, this fault alone will be enough to render them useless for most work.

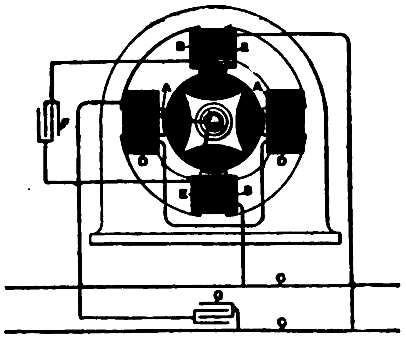


FIG. 1.

So far the condenser has been described as arranged in shunt to the circuit containing self-induction. It has then no effect on the circuit with self-induction, but affects the dynamo. In fact, it supplies exciting current instead of letting the dynamo supply it. The self-induction can, however, be counteracted by arranging capacity in series with it. For instance, suppose the alternate machine is made like one for direct currents, except that the field magnets are laminated. Suppose the machine in question is a 10 h. p. motor for 100 volts. If the field magnets are wound to suit 100 volts on a direct-current circuit, they will be only very slightly excited by the alternating pressure. If the number of turns is much reduced and the diameter increased, full excitation will eventually be reached, but the current will be enormous. For instance, if the magnets take two amperes on a 100-volt direct-current circuit, the loss in copper is 200 watts, but to drive two amperes through the inductive circuit with an alternate current would probably need something like 5,000 volts. If a few turns of large wire are used instead, the full excitation will probably be reached with about 100 amperes. Not only is the exciting current enormous, but the armature current is not in step with the field induction, so the output is lessened from this cause too. M. Leblanc was the first to point out the way to overcome these troubles by the use of condensers. A condenser may be put in series, of such a capacity that at the frequency employed the electromotive force of the condenser is always exactly equal and opposite to that of the self-induction of the magnets. This condition can only be attained approximately, as the pressure does not vary perfectly harmonically. If it did, all the electromotive force of the supply circuit would be spent on resistance, so that the same current would be produced as if the magnets were excited by a direct pressure. The field induction is then in step with the electromotive force, so that the armature current is so also, and the power taken by the motor is found by multiplying the pressure by the current.

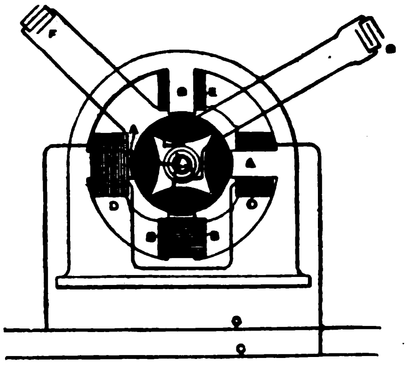


FIG. 2.

Messrs. Stanley & Kelly have designed and worked out a motor on this principle. It is constructed like an ordinary direct-current shunt motor, but has laminated field magnets. A condenser is arranged in series with the magnets. This motor has some drawbacks. In the first place, if the field magnets and armature are on a 100-volt circuit, the pressure on the condenser and on the field coils will be something like 5,000 volts, and this might make the motor too dangerous for admission to private premises. Of course this depends on the size and design of the motor. It may be possible to design a machine with much lower condenser pressure. The loss by hysteresis in the field magnets is also necessarily large; but that is not such a serious matter in a motor as in a transformer, which is on all day and all night. The next trouble is sparking at the brushes. The armature coils are short-circuited just at the time of the most rapid change of field, so that there is a large current in the short-circuited section. I would suggest that this trouble can be overcome by winding the armature with two separate circuits in parallel. The brushes then collect from both, but never short-circuit any of the sections.

The Tesla motor, as is well known, demands two or more currents differing in phase. Two currents differing a quarter of a period will do. At first special dynamos with double armature circuits were used as generators, but several arrangements involving condensers have been proposed. The first experiments of this kind were probably made by Prof. Ayrton and Dr. Sumpner. They had a small Tesla motor some years ago, but made up some arrangement with self-induction and capacity so as to split the single into a double current. The experiments have not been published, so I do not know what the exact arrangement was. Mr. Tesla has designed numerous arrangements himself; but the most complete investigations have been made by Messrs. Leblanc and Hutin, and those interested in this subject will do well to read the able articles in the *Lumière Electrique* which have been appearing recently at short intervals. These authors have gone most carefully and exhaustively into the whole subject of alternate-current motors of all sorts, and their papers are very suggestive. Fig. 1 shows a very simple arrangement due to them. One field magnet circuit E E has a condenser in series with it. Its current and induction are therefore in step with the pressure, and the wire used is the same as for direct currents under the same pressure. The other magnets A A, however, are wound with few turns of low-resistance wire B B, and take a large current, which lags practically a quarter of a period behind the pressure. In all practical cases the lag can be adjusted to a quarter of a period by using a condenser of the right capacity in the first circuit.

It is to be feared that there will be great difficulty in work-out this system to be right at various loads. As the load increases, an active current should flow in both circuits. The circuit with the condenser in series with it cannot take its load current, so that the full load output of this form of motor may be little more than half that of a double-current motor of the same size. It is probable, however, that the ingenuity of Messrs. Hutin and Leblanc in France, or Mr. Tesla in America, may overcome this drawback. A multiple-current motor is, however, thus obtained, which will work on ordinary supply circuits Only one of the sets of magnets takes a large "idle" current; but to avoid troubles from this a second condenser G in shunt to the mains C C or to the transformer that supplies the motors is advisable. This condenser is of the same cubical contents as the first, but unless arranged on the high-pressure side of the transformer it is designed for a much lower pressure and for a correspondingly larger current. By this means a self-starting motor can be obtained which has no brushes, which works on an ordinary supply circuit, and which gives full torque on starting. It has, however, the same drawbacks as the type first described. The dangerous pressure on the field coils of the first circuit may be reduced by arranging the magnet coils in small portions alternately. If the fields take 5,000 volts to drive the exciting current through, say, twelve coils, the coils and portions of the condenser may be arranged alternately, so that the maximum pressure is just over 400 volts due to the condensers. The fall over the resistance of the circuit is out of step with this, and may therefore be neglected. Mr. Tesla has also patented an arrangement on the same principle as Messrs. Hutin and Leblanc. He uses one field circuit partly as a transformer to transform up, and then places the condenser F in the secondary circuit D E D E. This seems rather to increase the difficulty arising from the very high pressures resulting from arranging condensers and induction coils in series. His arrangement is shown in Fig. 2. He has also put a condenser in the armature circuit, but it is difficult to see the inventor's object in this. Whether this form of motor is the motor of the future or not is difficult to say; but if it is, the number of condensers required will be considerable, so we are justified in discussing it at some length in this article.

There is still another possible use for condensers, and that is for exciting dynamos. An alternate machine may be regarded as made up of two elements. One has constant induction, and is called the field magnet; the other is variable, and called the armature. The field magnet may be excited by a direct current round it, or by an alternate current in the armature which is direct relatively to the field, because the armature changes position while the current changes its direction. As far as copper in the machine goes, it is cheaper to excite the fields by arranging the machine so as to have considerable armature reaction, and exciting by means of a condenser. Suppose when the field has its own coils the current density and weight of copper is the same in the field magnet and armature; if the field coils are removed and the condenser applied, the armature copper need not be doubled; it will carry the current at the same density as before, if the copper is increased in the proportion $\sqrt{2} : 1$. The total power wasted is then less than before; in fact, if the armature copper is not increased at all; the loss of power in the armature alone when the condenser is used is the same as that in the armature and field magnets together, with separate excitation. By the use of a condenser, cheapness, or higher efficiency, or a compromise of these can be obtained. The condenser itself is generally much cheaper than an exciter, and is of course very much more efficient. An alternate machine with a condenser follows practically the same laws as a shunt-wound dynamo, but it has only one copper circuit, and no commutator.

Perhaps enough has been said to show that condensers may have a large future. New possibilities are appearing every day, and there is no saying what combinations of capacity, self-induction, and resistance may be invented during the next few years.

CALENDARS FOR NEW YEAR.

WE have received a number of fine calendars for the New Year, and are making an æsthetic and effective disposition of them in our offices. Among them we may mention one from Mr. H. T. Paiste of Philadelphia, who, it will be remembered, has issued some very choice examples of time literature. We have also two calendars from the Commercial Cable Co. and the Direct United States Cable Co. The former is large, with a sheet pad; the latter has a leaflet pad, one leaf for each day. Pettingell-Andrews Co., of Boston, issue a large sheet calendar with big figures. The Bubier Publishing Co., of Lynn, is more modest in the proportions of its calendar, which is ornamented with a chromolithographic snow scene. The Ashton Valve Co., of Boston, have published a very tasteful calendar prepared for them by John A. Lowell & Co., who have put on it one of the finest "smooth" etchings. The Standard Paint Co., of this city, have sent us some charming little calendars for the pocket. They are printed in gold on tortoise shell, and are as useful as they are dainty. They are certainly "P. and B."—being both pretty and beneficial.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

THE HUM OF MOTORS.

FOR the benefit of Mr. Binney, I will somewhat further elucidate my theory of the cause of humming in motors.

Sound, as any one at all acquainted with physics knows, is a mode of motion produced by a peculiar vibratory movement of matter, and is transmitted by any conducting medium to the drum of the ear, and thence by auditory nerves to the brain where it is recognized as sound; and not, as Mr. Binney says, "set up by some force or forces other than those derived from motion."

I made the statement in my article that the movement in the armature was a progressive, undulatory movement of the iron; I should have said a progressive, undulatory movement *around* the circumference of the ring, not a progressive movement of the *iron*; that is, the iron does not progress, but simply has a *progressive movement*, as on waves of water the water does not progress, simply the movement. Mr. Binney seems to be unaware that all wave motion is progressive.

The intensity of attraction on any particular spot of the circumference of the ring, as it is revolving, is constantly varying, producing a vibratory movement of the iron and a progressive wave-like motion around the ring. The vibratory movement of the iron produces also a vibratory movement of the air surrounding it, which air transmits the vibration to our ears and we recognize it as sound. The wave-motion *around* the ring is undulatory and transverse to its line, or direction of propagation and is *not* sound (and I never claimed it was); whereas the vibratory movement of the iron transmitted by the air is longitudinal to its direction of propagation and *is sound.*

If Mr. Binney doubts the slightness of vibration being able to produce the sensation of sound, it would be well for him to notice the phonograph in which the little glass diaphragm appears motionless, and yet we know it vibrates and produces sound. Perhaps it would be easier for Mr. Binney to understand the action if he would imagine the poles to revolve about the armature, which would produce the same result.

I should be pleased to know what the "more admissible theories, already somewhat numerous," are.

CHAS. J. HAYES.

DETROIT, MICH., Dec. 24, 1891.

MR. STUART AND REACTIVE COILS.

THE letters by F. L. P. and Prof. Elihu Thomson, in your issue of the 16th inst., both take me to task for saying, in my article on "Reactive Coils," that Prof. Thomson first stated that if a magnetic field cut or is moved across a conductor, a current of electricity will be generated in the conductor.

Regarding the references to Faraday's "Experimental Researches" made by F. L. P., all I have to say is, that the "principle" is not stated therein. But I am aware that the principle was *known* many years ago. I do not remember that I have ever heard it *stated* except by Prof. Thomson. However, I am willing to be corrected by such eminent authority as Prof. Thomson, and the matter cannot, probably, be better stated than in his own words: "Any one who is familiar with the work of Faraday and others will understand that the principle was known many years before I was born, and is a fact so self-evident that no statement of it would be required," etc.

Concerning Prof. Thomson's next point I desire to say, first, that I am aware of the nature of his patent, No. 428,647; secondly, that I knew of the apparatus he mentions he had in his house in Lynn, and have myself operated the same; and thirdly, that I was aware of the "problematical" efficiency, so called, of reactive coils when used for such purposes.

Prof. Thomson's patent does not describe such a device as the Ries regulating socket. The device used by Prof. Thomson in his house in Lynn was not such a device as the Ries regulating socket. Nor was I considering *who* was the original inventor of the device.

In my opinion the Ries regulating socket is one of the most interesting applications of the reactive coil. I first saw this socket at the Montreal Exhibition last September. Since then I have seen it tested, and I was surprised to find its efficiency so high. My remarks on it were made because I desired to name an application of the reactive coil of the most general interest and usefulness.

The patentability of the Ries regulating socket is a matter of opinion which I will not attempt to discuss. It seems to me as worthy of a patent as many other patented devices—as worthy, for instance, as some of the regulating coils of the Thomson Electric Welding Co.

Otis K. Stuart.

Philadelphia, Pa., Dec. 28, 1891.

IRON ROOFS FOR LIGHT AND POWER STATIONS.

When building an electric light or power plant, one of the objects in view is to have its construction as fireproof as possible. In order to secure this I know of four stations where iron roofs have been placed. These answer very well in the warm weather, but as soon as it becomes cold, very rapid condensation is the result and if not remedied very serious troubles may be caused by the water falling on machines, switchboards, etc. I know of one lighting station in particular which I visited during cold weather and found that wooden sheds had to be built over the machines in order to run them. I would ask through your numerous readers the best means of obviating this trouble, as it appears to me to be one of no little importance.

It may be a little difficult with the so-called "iron bridge" roof, but by placing a light woodwork under the rafters I should say it would answer the purpose with the least expense. Trusting you will give this a space in your valuable columns,

Alfred E. Braddell,
Electric Inspector, Underwriters' Ass'n., Middle Dept.

Philadelphia, Dec. 29, 1891.

REACTIVE COIL IN A KEYLESS SOCKET.

I have read with interest the various articles in regard to the reactive coil as used with a socket for the regulation of an individual lamp. It may be interesting to note that in the early part of 1889, when manager of the Gardner (Mass.) Electric Co. the writer made a small reactive coil and attached same to a keyless socket. This device was attached to the wires in the house of the vice-president of the Co., and turned down and up a lamp screwed into the socket. Owing to other work pressing this was laid aside to await a more favorable opportunity for placing it on the market. The opportunity never arrived however.

Eugene T. Carpenter.

Forge Village, Mass., Dec. 26, 1891.

Society and Club Notes.

PROF. J. P. BARRETT BEFORE THE CHICAGO ELECTRIC CLUB.

A paper was read by Prof. Barrett before the Chicago Club on January 4, on "Electrical Exhibits at the Columbian Exposition." With regard to electric light and power, he stated that about 25,000 h. p. will be utilized in the shape of current in the building and grounds. He said that an important part of the electrical exhibit would be the original models and apparatus of some of the greatest inventions. As to prizes and awards, he remarked:

"It is not contemplated by the National authorities of the Columbian Exposition to offer awards which would have so great an intrinsic value as to attract exhibitors, but it is contemplated to make the standard of excellence so high that the bare acceptance of an exhibit by a department will be a lasting and distinguished honor. In the Electrical Department, the space available for exposition purposes will be so small as compared with the demand, that the greatest judgment will have to be brought into play to decide what exhibits are worthy of a place and what will have to give way. It will be impossible to accept all. Therefore the presence of an exhibit in the Electrical Building will be a testimonial of its unusual merit. The awarding committees have determined to have full and exhaustive tests made of all machinery in competitive exhibition, by the juries of the different departments, and to publish these tests and the jury findings, at the close of the exposition, under the authority of the National Commission."

NATIONAL ELECTRIC LIGHT ASSOCIATION.

Work is being actively pushed for the convention at Buffalo next month, and there is promise already of good papers and a large attendance. One of the gentlemen who will contribute to the proceedings is Mr. Erastus Wiman, whose subjoined circular letter explains itself:

"Having had the honor of being especially designated by Mr. C. R. Huntley, president of the National Electric Light Association, to address the next convention at Buffalo, on the special subject of the financial side of electric lighting, I am desirous of all the help I can get to make a careful and strong presentation of the merits of this class of property. There is believed to be in the public mind, and especially in financial circles, a growing prejudice adverse to securities based on electrical properties. It would seem important at this juncture that as clear a view as possible should be had of the real facts of the case. Hence, it would be very desirable if I could be placed in possession of instances of successful companies, with particulars of the amounts of their stock, the length of time before dividends were paid, and the amounts regularly realized, cost of maintenance, and such other facts as can be readily got together. Some special instances of very successful concerns are particularly wished for, and the history of companies which have not at first been successful, but which have since been rescued from insolvency by good management; also any facts relating to combinations between gas and electric light companies, and how best it can be promoted.

"If you happen to have anything of that kind and can send it for me to Mr. George F. Porter, 136 Liberty street, New York, I shall be much indebted."

NEW YEAR'S EVE AT THE NEW YORK ELECTRIC CLUB.

The entertainment at the New York Electric Club on New Year's Eve was voted a great success by all who participated in it, and the club house between 7 p. m. and 1 a. m. was visited by about 150 members. A most interesting and eloquent address on various features of journalism was delivered by Mr. Joseph Howard, Jr., a member of the club, and one of the most celebrated correspondents in the country. The address abounded in reminiscences of the elder and younger Bennetts, Horace Greeley, Henry J. Raymond, Henry Ward Beecher and others, and bristled with anecdotes and epigrams as well as with many well-directed criticisms on the less admirable aspects of modern newspaper work. Mr. Howard was listened to for over an hour with the deepest attention and received a warm tribute of applause.

The musical part of the entertainment was begun by Mr. Alfred Grünfeld, Imperial Court pianist of Vienna, Austria, who rendered a fantasia on the themes of Lohengrin and Tannhauser. The delicate touch of Mr. Grünfeld in the piano and pianissimo passages and the feeling and expression infused throughout his rendering were remarkable, and called forth well-merited applause. He was followed by his brother, Mr. Heinrich Grünfeld, Imperial Court violoncellist, of Berlin, who played a "Romanza," composed by Mr. Alfred Grünfeld. In response to a hearty encore, Mr. Grünfeld played the "Golden Wedding," by Gabriel Marie. In response to the continued and unremitting applause, Mr. Grünfeld rendered the "Guitarre" of Moskowsky. As a violoncellist Mr. Grünfeld undoubtedly ranks among the best who have thus far been heard in this country. One of the most characteristic performances of the evening was the rendering of the "Hungarian Rhapsody," composed by Mr. Alfred Grünfeld, in which he portrayed with masterly skill the peculiar intonations and effects of the Hungarian national instrument, the cymbal.

The vocal part of the programme was inaugurated by Mrs. Anna Lankow, the well-known alto concert singer and vocal teacher, who sang the celebrated aria from Gounod's "Mignon" with most consummate finish. As an encore Mrs. Lankow sang the alto aria from "Samson and Delilah." The programme was brought to a close by Sig. Victor Clodio, tenor in Gilmore's orchestral company and now of the Italian Opera Company, who sang Tosti's "Rosa" with excellent effect, his high B, *sostenuto*, calling forth enthusiastic applause. Mr. Friedberg, the well-known pianist, played the accompaniments to Mrs. Lankow and Sig. Clodio in the most finished manner.

After the regular programme had been gone through, Steward Reynolds filled the club punchbowl and served a collation. A few minutes before midnight Mr. George H. Guy played "Auld Lang Syne" on both the pianos in the club parlor, and his music was ably seconded by a large gathering of those who had lingered to see the New Year in. Steward Reynolds is entitled to much credit for the success of the arrangements in the club and for the excellence of the table d'hote dinner and later collation.

CHICAGO ELECTRICAL ASSOCIATION.

At the regular meeting of the Chicago Electrical Association, Dec. 22, Mr. A. H. Adams read a paper upon "Chimneys and Chimney Draughts"; Mr. L. G. Bassett read a paper upon "The Speed of Electricity." The following officers were elected for six months, to begin Jan 12: President, E. G. Hovey; vice-president, J. I. Connor; secretary, F. R. McBerty, No. 227 So. Clinton Street; treasurer, Albert Scheible. This association meets the second and fourth Tuesday evenings of each month at No. 169 E. Washington street, Chicago.

GRAND RAPIDS, MICH., ELECTRICAL EXHIBITION.

Grand Rapids is about to have an electrical exhibition under the auspices of the Electromathean Society. Space will be granted to manufacturers and dealers in electrical goods, for simply the payment of the expenses pertaining to their own exhibit. Some new and attractive features are promised. Mr. Eugene B. Palmer is chairman of the Committee on Advertising and Solicitation, and will be glad to furnish information to any one interested.

NEW ENGLAND ELECTRIC CLUB.

Gentlemen interested in the New England Electric Club have elected the following-named officers: President, Mr. Ferdinand A. Wyman; vice-president, Mr. E. A. Record; secretary, Mr. Lynn M. Hays; treasurer, Mr. A. O. Smith; board of directors, Mr. Charles C. Pierce, Mr. Maybin W. Brown, Mr. Elmer P. Morris. The officers, with Mr. E. R. Tilton and Mr. James E. Cotter, were appointed a committee on constitution and by-laws and also to take all necessary steps toward obtaining a charter, and to investigate, consider and report in regard to obtaining quarters for the club. The club starts off with a membership of 110.

Obituary.

GEORGE W. COSTER.

In the death by pneumonia, at Schenectady, N. Y., of Mr. George W. Coster, district manager Rocky Mountain District, the Edison General Electric Company has lost one of its most faithful, efficient and zealous officers. Mr. Coster was educated at the United States Naval Academy, graduating from that school in 1867. He remained in the Navy until 1880, when he resigned and went into business. While in the Navy he acquired a thorough knowledge of discipline and of the handling of men under him, which he afterwards utilized to good purpose in civil life.

Mr. Coster was connected with the Edison interests for the past six or eight years, and his ability as an executive officer had been thoroughly demonstrated. He possessed to a marked degree the ability to surround himself with able assistants, men peculiarly fitted for their positions, and to secure from them the most devoted loyalty. His entire office was permeated with a loyalty to, and enthusiasm for, the interests of the company, which he himself served so ably and so well. Mr. Coster is not only a great loss to the Edison General Electric Company, but to his many intimate friends connected with the electrical business, who remember his warm friendship and genial manners, his death comes as a severe personal loss.

Personal.

MR. R. G. BROWN.

The many professional and business friends of the above-named gentleman will be greatly interested in the news of his marriage to Dr. Lucy M. Hall, of Brooklyn. Mr. Brown, who is at present connected with the Interior Conduit and Insulation Co., has had an active career in telephonic and telegraphic fields in this country and abroad. Dr. Hall-Brown is a well-known and popular practitioner, vice-president of the medical alumni of Michigan University, secretary of the Department of Health, of the American Social Science Association, and has been in many positions of importance and influence.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO. vs. THE EDISON LAMP CO.—IV.

ARGUMENT OF GEORGE H. CHRISTY FOR THE UNITED STATES COMPANY.

But defendant had said further that so much of the invention as was of any practical utility, was Maxim's and not Weston's, and that all manufacturers in this country were using what was spoken of as the "attenuated-gas" treatment. Mr. Christy read Shallenberger's explanation of the attenuated-gas treatment, showing that a deposit within the pores and a deposit upon the surface went together as the inevitable result of the passage of a current through the carbon filament in the presence of hydrocarbon gas. What were the substantial marks of identity of the process? Weston's claim called for the carbon pencil, filament, illuminant; for the passage of a current to raise it to a proper temperature, and a surrounding envelope of hydrocarbon liquid or gas. With reference to what? Why, the "building up" of the carbon, by putting into it, or on to it, or both, a deposit of carbon from the surrounding carbonaceous envelope. This attenuated-gas treatment they were talking about, had every element of the Weston claim, working in the same way, with reference to the same end, and producing identically the same result. Clarke the defendant's expert, had admitted that the use of hydrocarbon vapor was a part of Weston's original invention. The point was that the use of hydrocarbon vapor constituted part of Weston's invention, whether attenuated or not. Yet defendant had tried to argue that attenuated gas—lighter gas and less of it—did not come within Weston's invention. But to go a step further, it was a fact that the oil never touched the highly heated body anyhow; it was always surrounded with vapor. If you stuck a red-hot poker into water the poker would not come in contact with the water; the heat would generate an envelope of steam around it; so it was with the red-hot carbons in oil. Although oil was one of the materials mentioned in the patent, as a matter of fact the work was actually done by hydrocarbon vapor or gas.

There was another singular fact in this case; his brother Betts had conceded that Maxim had done nothing of consequence, except perhaps making one lamp, down to 1880; that he made one lamp and took some patents. Defendant had nevertheless gone to the expense of bringing Maxim from England to examine him. In his testimony in 1891 Maxim magnifies this process; claims the credit of it himself and says that he worked it practically and publicly in 1878. But his testimony in the old interference case in the record, squarely contradicts his 1891 testimony and showed that everything he did down to 1880 had been purely experimental, and had been so admitted in his previous testimony. But Maxim, their own witness, had said that between a little less than one atmosphere and a highly attenuated atmosphere, the difference was simply a difference of degree and not of principle, exactly as he (Mr. Christy), had contended, for reasons set forth in Shallenberger's testimony. Moreover defendant did not use attenuated gas, and it did not lie in their mouth to say that something else than oil was better. They had used oil, and so far as the proof went it was the only thing they ever did use.

Referring again to defendant's brief, Mr. Christy said he had already shown that it contained erroneous statements of fact. He thought it also contained some bad statements of law. Under the heading, "Rules of Law Here Relied Upon," was this passage: "It is a fundamental principle of patent law that to entitle an alleged inventor to protection by a valid patent, it must appear that he was the first in this country to reduce the invention to a fixed, positive and practical form. That was not the law, said Mr. Christy, and it never was. The rule had been well settled by repeated adjudications, especially in this circuit, that the party who first conceived an invention, provided he used reasonable diligence in adapting and perfecting it, was the party entitled to the patent, and it made no difference who came in between. Mr. Betts' next proposition was: "Mere speculations of a party, or experiments incomplete and inconclusive in their nature, or the production of drawings or models, are insufficient to sustain the issue of prior invention when the burden is upon him to prove it. That was about as bad law as the other. Judge McKennan had said, that the first inventor might by drawings, sketches and models, carry back the date of his inception, and if he had meantime used reasonable diligence, he could thereby establish priority. The third proposition was equally objectionable and for the same reasons. There had been no citations of authorities in support of those propositions.

(To be continued.)

A QUESTION IN FIRE INSURANCE.

A **case** of much interest to insurance and electrical companies has been brought at Salem, Mass., before the Superior Court.

On the 26th of October, 1890, the night employees in the power station of the Lynn Gas and Electric Light Company discovered fire in the tower or monitor cupola over the engine-room. Attempts were made to extinguish the flames, but before it could be done the tower was charred and the main light wires burned off.

The result was a quick short circuiting of the station. So big a load was taken off the engine that it began to race, and in a very short space of time the big fly wheel was hurled in fragments through the solid brick walls of the building, carrying havoc everywhere. The station was pretty well wrecked.

It was insured for $9,000 against fire in 23 companies.

The companies refused to pay their policies because the damage and loss was from the racing of the engine, as they claimed, and not from fire.

The Lynn Electric Light Company brought suit on the ground that the damage was from fire, and that fire was the first cause, as but for the fire, the burning of the wires and the release of the engine the latter would not have run away and there would have been no explosion.

Mr. R. W. Pope, secretary of the American Institute of Electrical Engineers, delivered an interesting lecture on Dec. 18, at Fitchburg, Mass., in the city hall, under the auspices of the Fitchburg Board of Trade. His subject was: "Electricity: Its Past, Present and Future."

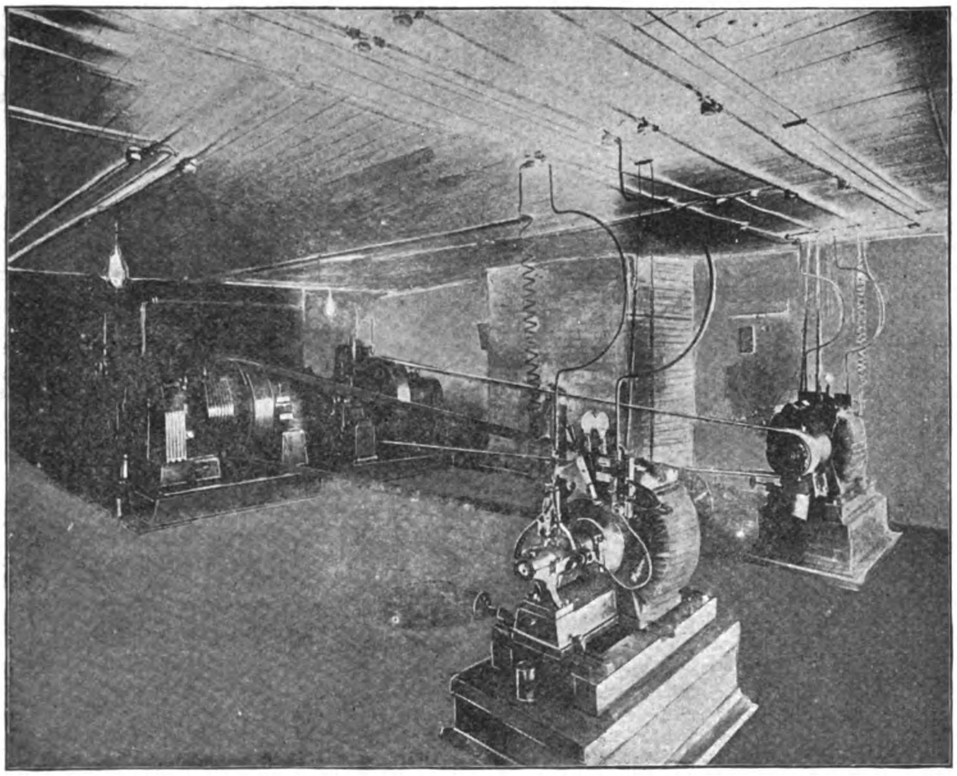
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The man who doesn't advertise is soon out of circuit or grounded.

A "C. & C." LIGHTING PLANT IN THE ST. NICHOLAS HOTEL, CINCINNATI, O.

THE illustration on this page shows the dynamo-room of the St. Nicholas Hotel, Cincinnati. The two generators have a capacity of 300 lights each and are of the standard "C. & C." type. The fields of the dynamos are compound wound and the entire machine is constructed with a view to attaining the highest possible efficiency. The armature shaft revolves in self-oiling bearings, and the whole machine rests upon a sliding base, which can be adjusted to tighten the belt. This installation was made by the "C. & C." Electric Motor Company, New York, about a year ago, and the dynamos have been in constant service since then. The fact that a 40 K. W. dynamo of the same type has recently been added to this plant to furnish current for an increased number of lights, gives evidence of the satisfaction which these machines have given.



"C. & C." LIGHTING PLANT IN THE ST. NICHOLAS HOTEL, CINCINNATI, O.

THE EQUITABLE ENGINEERING AND CONSTRUCTION CO.

THE Equitable Engineering & Construction Co., Drexel Building, Philadelphia, announce that on the 1st of January their company will go into liquidation. Their business for the past year has been a profitable one, but the active members of the concern wish to get out of the construction business.

Mr. S. Ashton Hand has accepted a position as superintendent of the Detroit Electrical Works, Detroit, Mich.. and Mr. W. A. Stadelman wishes to devote his time for the present to his interests in Bristol, Tenn., which consist of the Bristol Belt Line Railway and the Bristol and East Tennessee railroad, in both of which he owns a controlling interest.

The company retires from business with every debt paid and a good balance to be distributed as a dividend to the stockholders.

WESTERN ELECTRIC COMPANY—MORE FACILITIES?

WHEN, some eight years ago, the Western Electric Company purchased its extensive property in South Clinton street, Chicago, and erected a large building upon a part of it, it may well have been thought, even by the company itself, that abundant provision for its Western manufacturing and for its general offices had been made for a generation. Several extensive additions to the building have since proved requisite until the entire ground has been occupied, and yet more space is required for the company's constantly augmenting business. It is now reported that a purchase has been made of a block of ground adjoining the factory on the south, and known as the Collins and Burgie property, the ground measuring 300 by 200 feet.

Inquiry at the New York office of the Western Electric Co. fails to secure a confirmation of the report, and we have been unable to learn whether it is the intention of the company to erect extensive factory buildings upon the property at once, or not. It is the well-understood policy of the Western Electric Co. to maintain its manufactories within cosmopolitan cities, rather than in suburban locations near such cities, or in smaller towns. In accordance with this plan its manufacturing business is, at present, compactly located and organized in Chicago, New York, Antwerp, Berlin and in Paris.

It is also worth noting that the company has always refrained from premature announcements of its policies and intentions, preferring to await the completion of its facilities and extensions before notifying the world of them.

The report can hardly be without some foundation in fact, though we are not apprised of the purchase price of the real estate. The property includes several buildings erected by Collins & Burgie, who have conducted a foundry business on the premises for 30 years. The property can be worth scarcely less than half a million dollars, situated as it is, near the central business part of Chicago.

As the Western Electric Company has never been known to speculate in real estate, nor to undertake any piece of business just for the fun of the thing, it seems reasonable to infer that it is about to construct an extensive addition to its present Chicago factory.

F. P. LITTLE & CO.

THE above enterprising firm of electrical engineers of 141 East Seneca street, Buffalo, N. Y., have just closed a contract with William H. Walker & Co. for the installation of a 250 light Thomson-Houston incandescent dynamo and a Rice engine, for their new eight-story building on Pearl street, that city.

"P. & B" INSULATING COMPOUNDS.

A LETTER was recently sent by Mr. George P. Low, electrical inspector for the Pacific Insurance Union, 307 Sansome street, San Francisco, Cal, to the Paraffine Paint Co., San Francisco, who manufacture the "P. & B." insulating compounds on the Pacific coast, and for the territory west of the Rocky Mountains. The letter contained among other things, the following :—

"Permit me to express appreciation of the inestimable benefit you have conferred upon the electrical industry in perfecting and bringing out your "P & B." electrical compound. I know of nothing in the way of an insulating paint for all-around work that is compared to it."

The Pacific Insurance Union controls the entire insurance work of the Pacific coast, and early this year, Mr. Low made tests of all the insulating materials offered for sale on that coast to determine the safest insulation for the wiring of buildings. Severe tests of the compounds were made, the "P. & B." standing the tests better than anything else, and it is now compulsory that "P. & B." be used in all electrical work which comes under the control of the Pacific Insurance Union. The Pacific Postal Telegraph Cable Co. are painting their bare wires, on the Pacific coast, with "P. & B.," it having been demonstrated that wires so painted have worked perfectly during the heaviest rains, and the densest fog, while through the unpainted wires, not a tick could be heard at such times.

The Paraffine Paint Co. is the Western branch of the Standard Paint Co. of No. 2 Liberty street, this city.

THE THOMSON-HOUSTON CO. IN THE WEST.

THE Chicago office of the Thomson-Houston Electric Company has just closed a contract with the Benton-Bellfontaine Railway Company, St. Louis, for the equipment of thirty cars with two motors each of their latest improved type, known as the W. P., or waterproof. The contract includes the furnishing of three 333 h. p. compound-wound generators of the Thomson-Houston manufacture, and it is understood that the railway company will do everything that is required to make this installation a model, complete and perfect in every respect.

The Thomson-Houston Company have their electric railway equipment in exclusive use in St. Louis on the following roads: St. Louis & Suburban, Union Depot, Mound City, Missouri Railroad, Suspension Bridge and East St. Louis, and it is now believed that St. Louis has more T.-H. electric railway apparatus in use than any other city in the United States, with the single exception of Boston.

ENGINEERING EQUIPMENT CO.

FACTS "talk." These are facts, reported under date December 18th by the Engineering Equipment Company, of 143 Liberty street, New York. Recent shipments of Anderson's electric railway specialties—2987 "Ætna" insulators; 150 "Boston" trolleys, complete; of Anderson pull-offs, 536; terminals, 405; tree insulators, 925; hangers, 1,595; also miscellaneous shipments in considerable quantities of other Anderson specialties. All of the above were additional to direct factory orders Besides these shipments the Engineering Equipment Company report the following: 310 clips, 1,500 eye-bolts, 7,500 rail bonds, 400 turn buckles, 500 bond clamps, 625 trolley ears, 150 curve insulators, 430 trolley bells, etc. These and other materials not mentioned have been supplied to important electric railways in Massachusetts, New York, New Jersey, Pennsylvania, Georgia, Tennessee, Ohio, and in Canada.

The Engineering Equipment Company are the authorized sales agents for Messrs. A. & J. M. Anderson's reliable line apparatus and "Boston" trolleys.

OTIS K. STUART.

THE above-named engineer has now established himself at the City Trust Building, Room 21, Philadelphia, where he will not only act as agent for the Germania Electric Co. in the Southeastern district, but will handle such electrical supplies as dynamos, transformers, lamps, sockets, shade-holders, etc. All who know Mr. Stuart, and are familiar with his activity and versatility will expect for him a prosperous career in his new sphere of labor.

THE BURTON ELECTRIC COMPANY.

AT a meeting of the board of directors of the Burton Electric Company, held on Dec. 15 at the Citizens' Bank, Richmond, Va., the following resolution offered by Maj. Chas. R. Skinker, was unanimously adopted:

Be it resolved, That after hearing the favorable report of the superintendent, Dr. W. Leigh Burton, as regards the status of its business, we, the directors of said company, hereby desire to express our entire appreciation and satisfaction to Mr. W. R. Mason, president of the company, for the zeal manifested by him in the management of its affairs, and for his untiring efforts for the advancement of its interests; and to say, further, that we are well satisfied with the success of the enterprise up to this date.

THE SECURITY INSULATOR.

A VERY pretty and pithy little circular has just been issued by the Security Insulator Co., of 136 Liberty street, on the merits of their insulator, which was recently illustrated and described in our columns. The circular makes a neatly humorous statement of the good features of this insulator, the principle of which is that of the inclined plane. The wire fits snugly into the groove and is then held tightly by screwing the top cap down on it.

BALL ENGINES AT KEY WEST.

THE electric light plant being erected at Key West, Florida, is a source of great curiosity to a great many of the natives, who have never seen anything of the kind before. The three large compound engines furnished by the Ball Engine Co., Erie, Pa., are the centre of attraction, the largest engine on the island, hitherto, being an antiquated 6 h. p.

THE CARD ELECTRIC MOTOR AND DYNAMO CO.

THE above company, of Cincinnati, O., is now ready for business under its new incorporation. The officers are: J. W. Welshire, president and treasurer; George Bullock, vice-president; C. B. Simrall, secretary; G. B. Wilson, assistant secretary; and O. W. Jantz, electrician and superintendent. The company will push for business more actively than ever, and reports a bright outlook for the coming year.

HEAVY ELECTRIC TRACTION.

IT is stated that the Illinois Central Railroad is likely to adopt electric power for the purpose of drawing its heavy trains in and around Chicago, where the smoke of locomotives has become an intolerable nuisance. It is understood that the New York Central has had a similar idea under consideration for its New York terminal tunnel. The Illinois Central has appointed two of its directors, J. W. Doane and Norman Ream, a committee to investigate and report upon the feasibility of having all trains entirely propelled by electric motors.

FACING UP GENERATOR CASTINGS.

A NEW portable milling machine has been designed by one of tha foremen of the Thomson-Houston Company, at Lynn, for facing up the castings of big generators. The tool is said to do in five hours the work of four days when a planer is used.—*Engineering Record.*

NEW YORK NOTES.

THE EASTON ELECTRIC COMPANY, of Brooklyn, N. Y., lately sold to the Messrs. J. S. & G. F. Simpson, of 28 Rodney street, Brooklyn, N. Y., a six hundred light incandescent plant, consisting of a No. 9 Easton incandescent dynamo and the lamps. The plant includes a number of the Easton arc lamps which are operated on the incandescent circuit. The entire installation was made by the Easton Company and was pronounced a success. The plant is in daily operation on the premises owned by the Messrs. Simpson, and gives entire satisfaction. This is the sixth large plant which the Easton Company have lately installed in Brooklyn. This fact is good evidence that the work of the company is appreciated at home.

MR. H. WARD LEONARD has been called into consultation by the consolidated electric light companies of St. John, New Brunswick. When all the changes that he is to supervise and suggest are made, the company will have 180 arc lights, 5,000 incandescents, and a large power plant for running the street railway.

THE LAW BATTERY Co., of 85 John street, issued as a Christmas memento a huge stocking, which typified in a degree their own capacity for receiving orders. The stockings were greatly in demand and none have been returned as misfits.

MR. F. V. DOTY.—The marriage of Mr. Doty, the manager of the Aluminium Carbon Co., of Lancaster, N. Y., to Miss. Frances E. Olmsted is announced for January 14, at the Presbyterian Church, Geneseo, N. Y.

WALTER ROACH, the bookbinder, Pearl st. and Park Row, has lately put in a 5 h. p. Edison motor to run his large establishment and is more than pleased with electric power.

"A. B. C." GREETING.

WE have received from the enterprising house of Alexander, Barney & Chapin, of 20 Cortlandt st., an extremely tasteful and pretty souvenir of the season, accompanied by greetings for the New Year. It is adorned with portraits of the company's friends and "enemies." The portraits are very faithful, and the expressions will be recognized by everybody as wonderfully characteristic. The brochure is printed in colors and comes from the Bartlett press—a fact which speaks volumes for its typographic and artistic excellence.

STAR ELECTRIX.

THE Star Electrix Co. promise some new things in the way of electric lighting novelties to begin the new year. They will be put upon the market in a few days.

RECIPROCITY IN THE WEST INDIES AND SOUTH AMERICA.

THE new reciprocity treaties with the British West Indies and Salvador admit American electrical supplies and apparatus free of duties into those regions.

WESTERN NOTES.

THE ENGLEWOOD ELECTRIC LIGHT COMPANY are doing a very prosperous business in furnishing incandescent lighting in that section of Chicago, their business having increased 60 per cent. during the past year. Among other work that they have done of late, and which is well worthy of mention, is installing and furnishing current for 300 lamps in St. Cecilia Church, of Forty-fifth and Atlantic streets, for the Rev. E. A. Kelley. This church has been modeled after Notre Dame at Paris, and the lights are arranged one-half around the dome and also around the octagonal portion. On account of the distance of the lights from the station—some three miles—they have employed "boosters," manufactured by the Westinghouse Company, to give the required voltage at the lamps, making it a very interesting plant.

ELECTRIC APPLIANCE CO.—Any one happening into the busy store of the Electric Appliance Company during the last week of December would have wondered at the unusually busy appearance of the place which at no time since the new firm started has been anything but busy. The president of the company, Mr. Willard W. Low, had just returned from a business trip and any one familiar with the personnel of the Electric Appliance Company knows what that means. Mr. Low filled the Electric Appliance Christmas stocking with orders that made holiday week a very restless one for the employés of the company and a merry one for the firm.

ELECTRICAL SUPPLY CO.—Any device that is simple and which contributes to the ease of operating the dynamo is generally welcomed by practical engineers. The Wirt dynamo brush seems to have been a particularly happy design in this respect. The Electrical Supply Co., Chicago, who are the manufacturers, say that they have met with unusual success in introducing it. Engineers who have tried it say that it entirely prevents sparking and the consequent wear of the commutator. Each set is made to order. In this way they are certain to meet the exact conditions of service where used and give the greatest satisfaction.

THE ELECTRICAL SUPPLY CO., Chicago, the Western agents for the well-known "Boston" trolley, report a very marked increase of orders since the announcement of a reduction in price. They keep a full line of complete trolleys and parts in stock. They are also manufacturing a superior grade of raw-hide pinions which are meeting a ready sale. The general inclination of the trade is toward a better quality of supplies, and it is among this class of purchasers the Electrical Supply Co. find their largest buyers.

SOME QUICK WORK has recently been done in connection with the rearrangement of the Chicago Arc Light & Power Company's station recently destroyed by fire. On December 8, this company placed an order with the Chicago offices of the Pond Engineering Co. for a 200 h. p. Armington & Sims engine. The engine was shipped, complete, from St. Louis on the 9th inst. The railroad company delivered it in Chicago on the 14th inst., and on the 17th inst. the engine was ready for operation, and is now regularly driving six 50-light arc dynamos.

MR. F. E. DRAKE is now the selling representative of the Standard Electric Co., manufacturers of arc and incandescent systems of lighting, power generators and motors, at 313 to 317 So. Canal street, Chicago. Mr. Drake is an old telegraph operator, but for a number of years past has been interested in mining engineering in the West, and later in electrical work.

THE ELECTRIC APPLIANCE COMPANY are meeting with splendid success in introducing the New England switch to the Western trade and already report large sales. The Electric Appliance Company have inaugurated what we think a new departure in the electrical supply business; that is, the publishing of a catalogue especially devoted to toys and novelties for the holiday trade. About December first they printed quite an elaborate little catalogue of this character which they have distributed all over the country through the medium of the young people's periodicals, and which is bringing in quite a valuable trade in a small way. The Electric Appliance Company certainly deserve credit for this original idea and in placing before the people in general an opportunity of securing reliable electrical toys and novelties in the electrical line, as heretofore this business has been left to irresponsible dealers and the purchasers have been imposed upon to a large extent.

MR. ERNEST L. CLARK, widely known in electrical circles, has resigned as secretary of the Illinois Electric Material Co. He has organized the Ernest L. Clark Co., which will commence business the first of the year handling poles, ties, cross-arms and all kind of wooden material for electrical construction work. Mr. Clark's many friends will wish him the full measure of success in his new venture, returning as he does to his old line of business in which in the past he achieved an extended reputation and success.

THE RACINE HARDWARE MFG. CO., of Racine, Wis., have just received a second order from the Colorado Smelting and Mining Company, of Butte, Montana, for a 15 h. p. automatic engine for driving an electric lighting plant. This company have had a 10 h. p. of the same make at work for some time and the repeat order is the result of the excellent satisfaction given by this first engine.

MR. GEO. A. MCKINLOCK has returned, with his wife and infant daughter, to Chicago, from his wedding trip around the world, on which he has been gone for more than a year. He will resume his interests in the Central Electric Company and will be back shortly at his desk.

MR. CHAS. E. GREGORY, dealer in standard makes of dynamos, lamps and motors, has leased a floor at 205 So. Canal street. He furnishes machines of all makes and sizes, either new or second-hand, and also pays attention to installing of electrical plants of all kinds.

MR. L. K. COMSTOCK, the Rookery, is doing a general consulting electrical engineering business. He prepares plans and specifications for all kinds of electrical work and supervises the same. Mr. Comstock is meeting with good success here.

THE CENTRAL ELECTRIC COMPANY recently made the heaviest shipments yet in Swan incandescents. They are filling large orders right along, and the large and varied stock they carry enables them to make exceedingly prompt shipments.

CUTTER'S PLUG HAT INSULATOR. One of the odd orders lately received by George Cutter called for "those plug hat insulators that keep the ceiling white." Many who know his E. L. insulator may have other epithets for it.

GEN. C. H. BARNEY, of New York, was a visitor to Chicago, last week, He called at the Western office of THE ELECTRICAL ENGINEER. He was much interested in the progress being made on the World's Fair work.

PROF. D. C. JACKSON, instructor of electrical engineering of the University of Wisconsin, at Madison, Wis., was in Chicago, last week, visiting his many friends among the electrical fraternity.

MR. J. G. BECKERLEY, 229 So. Franklin street, is placing on the market a noiseless back-pressure valve for exhaust steam-heating purposes. It is a very simple and effective device.

THE CENTRAL ELECTRIC COMPANY are sending their friends their handsome calendar for 1892, and shall be glad to hear from those who are not supplied, so that they can be furnished.

THE CENTRAL ELECTRIC COMPANY have ready for distribution a handsome lithographed circular of the Bryant specialties, which have earned such a well-deserved reputation.

MR. C. A. BENTON, manager of the railway department of the Detroit Electrical Works, was a welcome visitor to Chicago last last week.

MR. N. P. SENAT, formerly connected with the *Street Railway Gazette*, of Chicago, has accepted a position with the *Chicago Herald*.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XIII. JANUARY 13, 1892. No. 193.

AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—I.

BY

Mary A. Henry

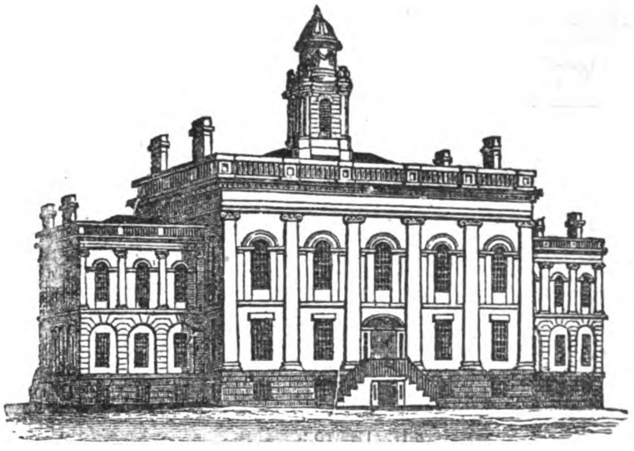
THE phenomena of self-induction and of mutual induction are closely connected, and indeed must be treated together as one whole in the modern theories of electricity and magnetism. After the discovery of self-induction by Henry, it seems to me but a step to the discovery of magneto-induction. This step was moreover made easy by the construction by Henry of electromagnets with great numbers of coils of wire. With a suitable galvanometer, also constructed with many turns of wire, there was sufficient residual magnetism in Henry's large electromagnets to give deflections of the galvanometer when the armature of the magnet was moved on or off the poles of the electromagnet, even when the latter was not excited by a battery.

MICHAEL FARADAY.

JOSEPH HENRY.

From a careful survey of the evidence presented, I believe that *Henry was the first to perceive the fluctuations of the galvanometer due to magneto-induction*, and that he had a conception of the relations of magnetism and electricity before Faraday published his first paper on the subject of magneto-induction. Henry has himself stated that he had perceived the phenomena of magneto-induction, and had been intending to study them further; but was prevented from pursuing the subject by unavoidable interruptions, and the desire to construct more powerful apparatus to continue his investigations. When we reflect that he had to insulate his wires with calico cloth, and to wind all his own electromagnets; that he was pursuing his investigations in Albany—then little more than a frontier town—while Faraday was at the Royal Institution, in the intellectual centre of the world, we feel that too much cannot be claimed for our countryman.—JOHN TROWBRIDGE.

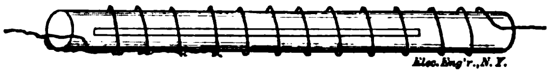
IN the year 1774, a question of no small significance was presented as a subject for prize essays by the Academy of Bavaria. The subject was one which even at that early day had excited deep interest in the scientific world; it was no less than "the identity of the two great mysterious forces, electricity and magnetism." The essays received in the competition were so numerous as to make 13 large folio volumes of matter, but the report of the Academy nevertheless was to the effect that "although electricity and magnetism are by some experimenters proved to be the same in some respects, in other respects they are dissimilar, so much so that they must of necessity be as yet considered as distinct." In this indeterminate state the matter rested for 56 years, until 1819, when, by the deflection of a needle Oersted became immortal. While the Danish philosopher was one day lecturing to his class in the University of Copenhagen, an experiment occurred to him and he tried it then and there for the first time. It was a simple matter; nothing more than the passing of a galvanic current through a wire parallel to and above a magnetic needle. Oersted found that under these conditions, the needle, swinging upon its pivot, turned eastward, and at length came to rest at right-angles to the wire, its north pole pointing east. When the wire was held below the needle, the north pole turned westward, and settled pointing west. What had happened here? What was there in this mere swaying of a bit of steel through an inch of distance to bring fame to a philosopher like Oersted? The little needle was not a common needle, a mere unresponsive fragment of steel. Endowed with the mysterious principle of magnetism, it had as one might say, a soul, and as human soul answers to human soul, it was quick to respond to another magnetic soul. Had an ordinary magnet been brought to bear upon it, in obedience to the magnetic instinct, it would have excited no surprise, had it responded to its influence. What then, we ask again, had happened in the experiment of Oersted? The little needle was behaving exactly as if the wire traversed by the electric current possessed magnetic properties. Was this, in truth, the case? Had electricity produced magnetism in or about the wire? Or was electricity itself magnetism? Oersted published four quarto


THE ALBANY ACADEMY, AS IT APPEARED IN 1826–32. FROM A CONTEMPORANEOUS WOOD-CUT.

pages on the subject;[1] the fame of his experiment spread with almost unexampled rapidity throughout the civilized world; it was repeated everywhere, and Schweigger seized upon the little needle to make of it the gavanometer,[2] so indispensable in the laboratory of the electrician from that day until this.

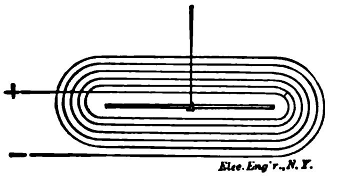
Very brilliant were the scientific men in the old world of that day, and about the year 1820 not a few of them were deeply interested in the question of the "identity of electricity and magnetism."

In the same year we find Arago and Sir Humphry Davy passing currents of electricity through wires and noting carefully the attractive power produced. Ampère caused two wires, each traversed by a current, to attract and repel each other, as if they indeed had been two magnets. Arago reached a result of no small importance; it was this: He placed a common steel sewing needle within a glass tube; around the exterior of the tube he wound a helical wire, through which the electric current was made to pass. The needle under these circumstances was found to become strongly magnetic.[3] Nature here asserted, in most unmistakable terms, that electricity could produce magnetism. Five years later we find Sturgeon bending a bar of soft iron into a horseshoe and by an obvious adaptation of Arago's method rendering it so strongly magnetic by means of a current of electricity, as to be capable of sustaining a weight of nine pounds.[4]



MAGNETIZATION OF STEEL NEEDLE BY ARAGO, 1820.

There is not the shadow of a doubt, after the year 1825, that electricity can produce magnetism; but the reverse, Can magnetism produce electricity? With ever-deepening interest as year after year goes by, the scientific world asks this question, but with all the most eminent men of Europe at work upon it, nature vouchsafes no reply, and so we come down to the last days of August, 1831, and to two men, one in the old world, the other in the new, at work upon the problem, each unconscious of the other, an ocean between them. One of these men is Michael Faraday, professor of chemistry in the Royal Institution of Great Britain; the other is Joseph Henry, professor in the Albany Academy in the State of New York. These two were destined to find the key to the problem; the answer to the question which had baffled the world of science for half a century.



SCHWEIGGER'S GALVANOMETER, 1820.

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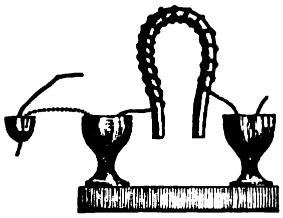

STURGEON'S ELECTRO-MAGNET, 1826.

We say the last days of August, 1831, because at that date, the work of the two men nearly touch in point of time; but the actual discovery of magneto-electricity, the reader will see, if with kind patience he will follow our story, had been made by the one, that is, Henry, at least a year earlier, namely, in August, 1830, while it was not fully accomplished by the other until some thirteen months later, namely, the 24th of September, 1831; for this we shall find to be the date at which Faraday first fully recognized the phenomenon, and the principle by which it is controlled.

To understand properly the work of these two men, in reference to the discovery of magneto-electricity, it is necessary to know something of the circumstances in which they were placed. When Sir Humphry Davy was asked, which he considered his greatest discovery, he answered, "Michael Faraday." Entering the Royal Institution in an humble capacity in 1813, the flower of his genius growing and expanding under the fostering care of Sir Humphry, Faraday had attained a high position, and an enviable scientific reputation, in the great London institution. Director of the laboratory, he was surrounded by every possible facility for the prosecution of his investigations; and what was perhaps even more important, had unlimited time at his command in London, the great centre of scientific light. He was now forty years of age. Henry was nine years younger. When Faraday first entered the Royal Institution as an assistant, Henry was but thirteen. Counting the years of his age with those of the century, he had entered upon a course of original investigation as early as 1827, but amid such arduous duties as an instructor in the Albany Academy, that of all the twelve sisters of the year, he could only claim the month of August, the vacation time of the institution, as really his own. During four years he had been able to secure hardly more than as many months for regular scientific research. Could we look into his laboratory at this time, we would find, instead of the well-filled cabinets of the Royal Institution, only a few rude instruments made at great expense of time and labor by his own hands. Even the material for these rude tools was often difficult to obtain. Experiments, for instance sometimes stopped merely for the want of a scrap of zinc. We say "could we look into his laboratory," but we would seek in vain for a room which could properly be so called. Each series of experiments was necessarily carried on in the large hall of the Academy, which was available for Henry's use at no other time than during the summer vacation. Invariably all investigations came to a stop with the first of September, the beginning of the autumn session of the Academy, and were rarely resumed

FARADAY'S LABORATORY IN THE ROYAL INSTITUTION.

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[1] A verbatim copy of Professor Oersted's original communication, in Latin, and a translation of the same may be found in *Journal of the Soc. of Tel. Engrs.*, v, 459, 464; together with a biographical sketch of Oersted by C. L. Madsden. [EDITOR.

[2] Schweigger's first galvanometer was a very simple affair, consisting of a small compass box, around which was coiled several turns of copper wire in a direction parallel to the meridian line of the dial. See *Schweigger's Journal für Chemie and Physik*, xxxi, 1-17. [EDITOR.

[3] Arago's experiments were published in *Annales de Chemie et de Physique*, xv, 93. Immediately afterwards, but before any account of Arago's experiments had reached him, Davy had also magnetized needles by the voltaic current, and by discharges of frictional electricity. He had also discovered the attractive effect of the conductor upon iron filings. His letter to Wollaston, recounting these experiments, is in *Philosophical Transactions*, 1821. It bears date Nov. 12, 1820. [EDITOR.

[4] *Transactions Society of Arts*, 1825, xliii, 38-52. The accompanying illustration is a fac-simile of that annexed to Sturgeon's paper.

until the month of August came again.[5] The invaluable stimulus of scientific intercourse and appreciation too, was wanting. Very different was the dull commercial town of Albany, from London, the intellectual metropolis of the world. A wide expanse of waters, not yet crossed by the swift ocean steamer, lay between Henry and all the culture of the old world, and in provincial America, little could be found to make good its place. Moreover, it must not be forgotten that Henry was the first who had undertaken a series of electrial experiments in America since the time of the immortal philosopher who first drew lightning from the clouds; "the mantle of Franklin"—said Sir David Brewster—"has fallen upon his young shoulders." Excepting Dr. Hare of Philadelphia, who was making notable improvements in galvanic apparatus, almost alone in the electric field, he stood to face the army of the old world.

Recalling the wide difference in condition surrounding the two, it is of no small interest now to see to what eminence each had at this time attained, the one during his eighteen years of culture and unimpeded work; the other in his few months of intermittent study, snatched at long intervals from the crowded days of four years of arduous professional labor. Constantly pursuing similar investigations, making many identical discoveries, Faraday and Henry seem like two competitors in a closely contested race, upon whose course we have suddenly come in these August days of 1831, and with curious eyes we scan the field to see how they are running. Bence Jones says:

> "If Faraday's life had ended at this time, when he finished his higher education, it might have well been called a noble success, but when we turn to the eight volumes of manuscripts of his *Experimental Researches* which he bequeathed to the Institution, we find that *his great work was just going to begin.*"[6]

Henry had begun his course with a series of original discoveries which might well weigh in the balance with anything Faraday had as yet accomplished, while in the particular field in which lay the "*great work*" of Faraday, which he was now "*just going to begin*" he had not only entered, but was already far ahead. The mysterious phenomena of the induction of electric currents, the reciprocal production of the magnetic and electric forces, were to him already old stories, intimately familiar, singularly well comprehended by him at this early date. He is in truth but amplifying the results which Faraday has just begun to seek, in these waning days of the summer of 1831. The younger man, as it were, had struck almost immediately into this particular path, and is now almost lost to sight in it, while the elder has only just come to the spot where his entering footsteps began.

Let us dwell for a moment upon the importance of the answer to the great question we have been considering, the value to the world of the discovery made by these two men.

It is not too much to say that it constitutes a veritable epoch in electrical science; upon it depend many of the most important applications of electricity to the uses of man, and new applications are developing day by day. Tyndall, the successor of Faraday in the Royal Institution, does not attempt to restrain his enthusiasm in the contemplation of it:

> "I cannot help thinking" (he says) "when I dwell upon it that this discovery of magneto-electricity is the greatest experimental result ever obtained. It is the Mont Blanc of Faraday's own achievements. He always worked at great elevations, but higher than this he never attained."[7]

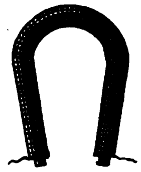
Edward N. Dickerson, the eminent advocate, said of Henry:

> "The towering heights that were scaled by the daring spirit of Faraday from the East, were at the same time surmounted from the West by our own countryman; both were climbing from opposite sides at the same time, and neither was conscious of the other's efforts till both stood face to face upon the summit."[8]

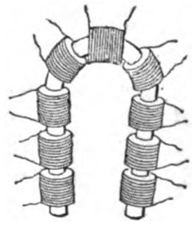
But the standard of the West had been floating many months upon these towering heights before the standard of the East was planted. It was Henry's foot, not Faraday's, which first touched the untrodden peak.

It was curious, that with such a host of the most brilliant minds of Europe at work upon the problem, the discovery which solved it was so long delayed. But there was a fact, which, it would seem almost with malicious or mischievous intent, successfully eluded all research. This fact was the necessary condition of *motion or change* for the production of the effect, and consequently the transitory nature of the phenomenon. If a magnet is thrust into the opening of a hollow helix of wire, electricity is manifested in the wire, but only for a brief instant, when the magnet is inserted and when it is withdrawn.

There is a fairy tale of a farmer's wife, whose heavy labors were lightened by a friendly gnome, who was never seen because he could never be caught at the moment he was at work. In all these years magnetism had been producing electricity under the very hands of these wise philosophers, but had never been detected in the act. *It was not caught at the moment it was at work.*



HENRY'S INTENSITY MAGNET.



HENRY'S QUANTITY MAGNET.

Let us see in what way Faraday and Henry, these two favored children of nature, ask of her the all-important question, so as to win at last a reply. Courtesy to the elder man and to the inhabitant of another country, would seem to suggest that we first go over the sea to Faraday; but this may not be, for we must look among Henry's own instruments for the stepping-stone to the great discovery, made by Henry's own hands to be a stepping-stone not only for himself but for Faraday.

Young Henry had before this time, as one of his friends has said, "made the lightning his familiar, his demon, his servitor; had lured it into his lecture-room from out of its cloud home in the thunder-storm, and tamed it so that he could bridle it, mount, ride it and spur it at will."[9]

He had taken the soft iron horseshoe of Sturgeon, with its spiral of loose uninsulated wire, an infant lifting but a few pounds at an inordinate expense of battery power, and had transformed it into a giant capable of sustaining fifty times its own weight, under the stimulus of a battery of a single pair of plates of copper and zinc, scarce a hand's breadth in area. He had made two magnets; his "intensity" magnet with a long single wire, and his "quantity" magnet with many short wires; the latter the stronger in actual physical force, but the former endowed with the subtle capacity which enabled it to respond to the electric influence at long distances; the magnet, in fact, which made the electric telegraph a commercial possibility instead of a philosopher's plaything. He had discovered and made plain the law governing the relation between the electric flow and the electric resistances in battery and magnet, and by this discovery had married, as it were, his magnets to their respective batteries; the "intensity" magnet of a long single wire to the "intensity" battery of many pairs of plates; the "quantity" magnet of many short wires to the "quantity" battery of a single large pair of plates; and had sent forth these children of his brain, through the pages of *Silliman's Journal*, to take their places as willing servitors in all the physical laboratories of the world; all this in the early days of this very year, in January, 1831.[10]

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[5] The Albany Academy, in which Joseph Henry occupied the chair of Mathematics and Natural Philosophy from 1826 to 1832, is an institution which for three quarters of a century has been held in deservedly high esteem, not alone in the community in which it is situated, but throughout the United States. Among the oldest foundations of its kind in the country, "its venerable walls seem imbued with that subtle spirit of the past, that favors study, and that nothing but time can give." The Academy building, beautifully situated on the public square near the head of State street at the right of the Capitol, is a dignified and admirable architectural example of the classical or "colonial" type. In the words of the late Dr. Meads in his oration at the semi-centennial anniversary of the Acadamy in 1863:—"Time has not rendered it in any degree unfitted for its purposes, nor unworthy of its position among the public buildings of Albany. It seems to have had a power to charm down and repress even the proverbial destructiveness of youth, and it stands to-day, after the lapse of half a century, unmarred by any spoiling hand, in all its original freshness and beauty."

The room in which Henry prosecuted his memorable experiments in electricity and magnetism, during the vacations of the Academy, has remained almost unchanged since his day. It is a lofty, well lighted and spacious hall of admirable proportions. and chaste and classical decoration, and is in no respect unworthy of the interesting associations that cluster about its venerable walls. [EDITOR.

[6] *Life and Letters of Faraday*, i, 384.

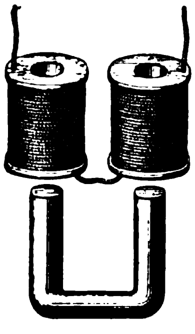
[7] *Faraday as a Discoverer.*

[8] *Joseph Henry and the Magnetic Telegraph*, p. 11.

[9] S. S. Cox, Memorial Speech in the House of Representatives Jan. 16, 1879.

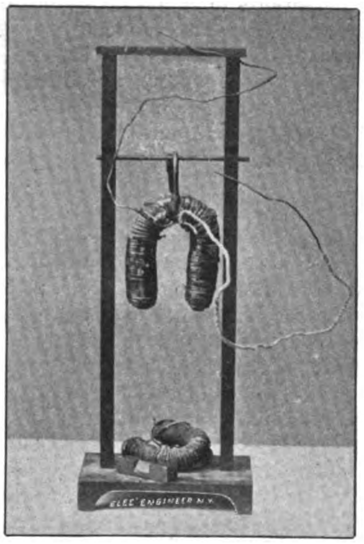
Prof. William B. Taylor says:

> "The importance of this discovery can hardly be over-estimated. The magnetic 'spool' of fine wire, of a length—tens and even hundreds of times as great as that ever before employed for this purpose was in itself a gift to science which really forms an epoch in the history of electro-magnetism. It is not too much to say that almost every advancement which has been made in the fruitful branch of physics since the time of Sturgeon's happy improvement; from the earliest researches of Faraday downward has been directly indebted to Henry's magnets. By means of the Henry 'spool' the magnet almost at a bound was developed from a feeble childhood to a vigorous manhood. And so rapidly and generally was the new form introduced abroad among experimenters, few of whom had ever seen the papers of Henry, that probably very few indeed have been aware to whom they were really indebted for this familiar and powerful instrumentality. But the historic fact remains that prior to Henry's experiments, in 1829, no one on either hemisphere had ever thought of winding the limbs of an electromagnet on the principle of the 'bobbin,' and not till after the publication of Henry's method in January, 1831, was it ever employed by any European physicist."



THE PRINCIPLES OF THE SPOOL OR BOBBIN, AS APPLIED BY HENRY TO THE ELECTRO-MAGNET.

> "But in addition to this large gift to science, Henry has the pre-eminent claim to popular gratitude of having practically worked out the differing functions of two entirely different kinds of electromagnet; the one surrounded with numerous coils of no great length, designated by him the 'quantity,' the other surrounded with a continuous coil of very great length designated by him the 'intensity' magnet. The latter and feebler system (requiring for its action a battery of numerous elements) was shown to have the singular capability, never before suspected or imagined, of subtle excitation from a distant source. *Here for the first time is experimentally established the important principle that there must be a proportion between the aggregate internal resistance of the battery and the whole external resistance of the conjunctive wire or conducting circuit.* This was a very important, though unconscious, experimental confirmation of the mathematical theory of Ohm, embodied in his formula expressing the relation between electric flow and electric resistance, which, although propounded two or three years previously, failed for a long time to attract any attention from the scientific world."
>
> "Never should it be forgotten that he who exalted the 'quantity' magnet of Sturgeon from a power of twenty pounds to a power of twenty hundred pounds, *was the absolute* CREATOR *of the 'intensity' magnet; and that the principles involved in this creation constitute the indispensable basis of every form of magnetic telegraph since invented.*"[12]



INTENSITY MAGNET MADE BY HENRY IN 1829; NOW IN THE CABINET OF THE COLLEGE OF NEW JERSEY.

It detracts nothing from Henry's independent and original discovery of the law of relation between the "electric flow" and the "electric resistance," that Ohm, in far-distant Munich, had a theoretical dream of such a law, which, with a sagacity little short of marvellous, he reduced to a concrete mathematical formula. Consider for a moment the distinction between the man who propounds a theory and the man who makes a veritable discovery; for precisely in these two attitudes stand Ohm and Henry in relation to this fundamental electric law. A theory may, it is true, be of inestimable value; but however ingenious, however founded upon intimate knowledge of the subject, it at the most can only suggest *what may be;* can only point out an intelligent mode of asking Nature a question. The theory may, or may not, prove to be true. A discovery, on the contrary, tells us *what is;* it tells us that a certain fact or a certain relation in nature actually exists. Of the theory of Ohm, now at the tongue's end of every schoolboy, but for a long time ridiculed, or at least unnoticed by the scientific world, Henry, in far-distant America, knew absolutely nothing. Five years later, in a letter written from Princeton, dated December 17, 1833, we find him asking Dr. Bache: "Can you give me any information about the theory of Ohm? Where is it to be found?" In another letter of about the same period: "Who is Ohm? What is his theory?" It was not until 1836, during his visit to London, that he sees at last Ohm's theory, and finds that, after all, it is in substance nothing more nor less than his own discovery, interpreted in the language of mathematical prophecy.

ASBESTOS PORCELAIN.

IN a recent communication to the Académie des Sciences, M. F. Garros called attention to a new form of porcelain brought out by him. He takes asbestos fibre and reduces it to a fine powder. If pure, it exhibits an exceedingly white apparence, but if traces of iron oxide are present there is a slightly yellow tint. In the latter case the oxide is removed by sulphuric or hydrochloric acid. The powder is then made into a paste, moulded into shape, dried slowly, and baked (1200° C.) from 17 to 18 hours. If placed in a very high-temperature furnace, a remarkably transparent species of porcelain is obtained. This "asbestos porcelain" has already been used for filtration and sterilization purposes, experiments showing that it is a more rapid and effective filterer than ordinary porcelain, and that the pores are less liable to become clogged up.

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[10] Silliman's *Amer. Jour. Science*, Jan. 1831, xix, 404-5.

[11] "It is evident"—says Mr. Fahie—"that it was not until after the interview with Henry [on April 11, 1837] that Wheatstone recognized the applicability of Ohm's laws to telegraphic circuits, the study of which would likewise have enabled him to ascertain the best proportions between the length, thickness, etc., of the coils, as compared with the other resistances in the circuit, and to determine the number and size of the elements of the battery necessary to produce the maximum effect." [*History of Electric Telegraphy*, p. 515.] Yet Wheatstone—characteristically, it must be said—has not hesitated to claim Henry's discovery for himself. In a statement written by him in 1841, to be presented to the arbitrators in a disagreement which had arisen between himself and Mr. Fothergill Cooke, he says:—"These methods of completing the secondary circuits have lost nearly all their importance, and are scarcely worth contending about, *since my discovery, that electromagnets may be so constructed as to produce the required effects by means of the direct current even in very long circuits.* [*The Electric Telegraph; Was it Invented by Professor Wheatstone*, ii, 96.] In a subsequent portion of the same document he nevertheless says of himself:—"Wherever I have borrowed an idea from Ohm, Gauss, Steinheil, or any other person, I have, and shall always be ready to acknowledge it." Yet Henry's paper in *Silliman's Journal*, had then been published for some years, and Henry himself had explained to Wheatstone in King's College, on April 11, 1837, the construction and use of his "intensity" magnet. In later years, however, Wheatstone became somewhat more guarded in his assertions, for we find him writing to Cooke in 1856, in reference to the same matter:—"With this law and its applications, no persons *in England* who had before, occupied themselves with experiments relating to electric telegraphs, had been acquainted." The words which we have italicized are significant, and are only capable of construction as an acknowledgment—though not a particularly graceful one—of the priority of Henry. [EDITOR.

[12] *Memorial of Joseph Henry*, pp. 226, 227.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—I.

BY

Francis B. Crocker and S. S. Wheeler.

INTRODUCTION.

THE purpose of these articles is to set forth the more important facts which present themselves in the actual handling of dynamo-electric machines and electric motors, as a guide for those who use or study these machines. The authors do not claim for this treatment of the subject that it is anything more than a set of directions in which the various points are arranged under headings for convenience of reference.

The subjects considered are: Chapter I, General Principles of Dynamos and Motors; Chapter II, Directions for Selecting; Chapter III, Installing; Chapter IV, Starting; Chapter V, Running; Chapter VI, Stopping; and Chapter VII, Testing Dynamos and Motors; also Chapter VIII, Directions for Locating and Remedying Troubles in these machines.[1]

Heretofore writers on the dynamo or motor have usually treated these machines entirely distinctly, and books or papers on the dynamo usually contain nothing about the motor, or merely consider it briefly in a few special chapters, and books on the motor only refer to the dynamo incidentally. The authors have found that there is no necessity for this separation; in fact, nine out of ten statements which apply to the dynamo are equally applicable to the motor, and if the word machine is used instead of dynamo, the statement covers both and becomes doubly important and useful. Occasionally, of course, it is necessary to distinguish between the two machines, but, as a matter of fact, the difference in treatment required for dynamos and motors is often less than for different kinds of dynamos; for example, a shunt dynamo and series dynamo differ from one another much more than do a shunt dynamo and shunt motor.

CHAP. I.

GENERAL PRINCIPLES OF DYNAMOS AND MOTORS.

Definitions.—*A dynamo-electric machine is a machine for converting mechanical energy into electrical energy;* in other words, *it generates electric current when driven by mechanical power.* The term dynamo-electric machine is so long that it is usually and unavoidably shortened into "dynamo," which has exactly the same meaning. The name "electric generator" or simply "generator" is often applied to the dynamo, especially when used to produce current for electric railway or other motors, but this distinction is merely for convenience. An alternating-current dynamo is commonly called an "alternator."

An electric motor is a machine for converting electrical energy into mechanical energy; in other words, *it produces mechanical power when supplied with an electric current.* An electric motor is usually called simply a motor, and although motor might mean anything producing motion, it is very rarely used in any other sense and is perfectly definite in connection with electrical matters.

Principles of Action.—The dynamo is based upon the discovery made by Faraday in 1831, that an electric current is generated in a conductor by moving it in a magnetic field. The electric motor works on the principle that a conductor carrying a current in a magnetic field tends to move. Thus it will be seen from the above statements that the dynamo and motor are exactly the reverse of each other in their action.

Similarity of Dynamos and Motors.—The two machines are, however, very similar in their construction. In fact, the same machine can be used for either purpose equally well. In practice there are sometimes slight differences between dynamos and motors, as will be explained further on, but these are not very important. Hence, as already stated in the introduction, the two machines will be treated as one, except where some distinction is specially stated.

General Form.—We have seen that both the dynamo and motor depend for their action upon the movement of conductors in magnetic fields. Now it has been found as a result of scientific experiment and practical experience during the 60 years since Faraday's discovery, that the best way to carry out this principle is to arrange the conductors in suitable form and rotate them between the poles of a magnet, or magnets. This rotating part is called the *armature* and the magnet is called the *field magnet.* In alternating-current dynamos this plan is sometimes reversed, the field magnets being made to rotate and the armature being fixed.

Armature.—This usually consists of an *armature core* of iron on which are wound or attached the conductors which carry the current. This core should be split up or *laminated,* that is, made of discs, tape or wire, of iron separated by paper, varnish or rust, instead of one solid piece; otherwise it will have useless currents generated in it which would waste the power of the machine. This core is almost always made either in the form of a *drum* or a *ring* and hence we have these as the two principal types of armature.

Field Magnet.—This consists of one or more iron *cores* on which are wound the field *coils.* Attached to the field cores are the *pole-pieces* which form the magnetic field or space in which the armature revolves.

CHAP. II.

DIRECTIONS FOR SELECTING DYNAMOS AND MOTORS.

The choice of a dynamo or motor will, of course, depend largely upon the circumstances in each particular instance. There are, however, certain general facts which apply to almost all cases.

Construction.—This should be of the most solid character and first-class in every respect, including material and workmanship, both of which should be of the best possible quality. All the parts should be of adequate size and strength to ensure durability.

Finish.—What is called a fine finish on a machine is also very desirable, first, because it indicates good construction, and its absence indicates poor construction (there is no essential reason for this, but it seems to be a fact in most cases), and second, it usually causes a machine to receive much better treatment.

Simplicity.—The machine and all its parts should be as simple as possible, and any very peculiar or complicated part or attachment should be avoided. These are sometimes successful but should be well tried and proved before accepting.

Attention.—The amount of attention required by the machine should be small; for example, the brushes should be capable of being easily and securely adjusted, and the oiling devices should be effective and reliable, self-oiling bearings being very desirable. The screws, connections and other small parts should be arranged so that they are not liable to become loose, and the delicate parts should not be particularly exposed or liable to injury. The machine should be made so as to be easily and thoroughly cleaned.

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[1] This chapter has already been published in the Sept., Oct. and Nov., 1891, issues of THE ELECTRICAL ENGINEER, under the title of "The Localization and Remedy of Troubles in Dynamos or Motors."

Handling.—The machine should be provided with rings or other means by which it can be easily lifted or moved without injury. It should be possible to take out the armature conveniently by removing one of the bearings.

Regulation.—Some form of regulator should be provided by which the E. F. M. or current of a dynamo or the speed of a motor can be reliably and accurately governed.

Armature.—This should turn very freely in the bearings, and should be perfectly balanced so as not to have any appreciable jar or vibration at full speed. There should be a uniform clearance of at least $\frac{1}{16}$ inch all around between the armature and pole-pieces. The armature should be capable of moving lengthwise in the bearings at least $\frac{1}{8}$ inch. It is not usually desirable to have the speed of an armature at its circumference more than 3,000 feet per minute. The ring-form of armature is especially suited to high voltage since the coils differing most in potential are at the greatest distance apart. A section of a ring armature can also be more easily rewound than in the case of a drum armature.

Capacity.—This should be ample in all cases. It is a very common mistake to underestimate the work required of a given machine, and, even if the machine has sufficient power at first, the demands upon it are apt to increase and finally overload it. No one is ever likely to regret choosing a dynamo or motor with a considerable margin of capacity, since these machines only consume power in proportion to the work they are doing. For example, a 30 h. p. machine would probably run with a 20 h. p. load more economically and satisfactorily than a 20 h. p. machine with the same load.

Form.—The machine should be symmetrical, well proportioned, compact and solid in form. If it is either very tall or very flat it is usually inconvenient and clumsy. No part of the machine should project excessively, or be awkwardly formed or arranged. The large and heavy portions of the machine should be placed as low as possible to give great stability. For the same reason the shaft should not be high above the base, nor should it be so low that there is not ample room for the pulley or other attachment. A horizontal belt, for example, will sag and strike the floor if the pulley is very low.

Weight.—The common idea that it is desirable to have a very light dynamo or motor is a mistake when it is for stationary use. There is no advantage in a light machine for stationary work, and it has the disadvantages of being less strong, less durable and less steady in running. A sufficient weight to make the machine thoroughly substantial is obviously a great benefit.

Cost.—It is also a mistake to select a cheap machine, since both the materials and workmanship required in a high quality dynamo or motor cost more than in almost any other machine of the same size and weight.

(*To be continued.*)

ONE WAY OF SAVING POWER ON ELECTRIC RAILWAYS.

BY LUCIUS ELLIOT MARPLE.

It is a well-known fact that much of the power generated at the central station of an electric railway is lost in overcoming the resistance offered by poor rail connections. Not only this; but there is consequently a much greater wear and tear on the machinery, and an undue heating of the motors because of the unsteady current resulting. As these are prominent features, it is of no small importance to the railway superintendent that there should always be the best possible connections between the car wheels and the rails.

The following instance, in which the writer was recently called in court to testify, shows that this may be the cause of annoyance in more ways than one:

A car happened to be stalled by dust on the track for a moment, when a "green" horse passing by took fright at it and stumbled, striking his head on the step of the car. It was claimed before the magistrate, and allowed, that a current of electricity from the car had, in some way, caused the animal's death. This decision was appealed from, and happily reversed in a higher court.

Several railways, have, however, overcome this trouble and effected quite a saving by applying water to the tracks in the proper manner.

The simplest and most effective way seems to consist in employing specially made carts, with wheels just fitting between the tracks. On each pair of wheels a large tank is placed six feet or more above the ground. By means of pipes, this delivers a stream of salty water with considerable force directly over either track.

By making several trips daily over each route, the tracks can be kept thoroughly clean and moist. Where this has been tried it has been proved that a very considerable amount of power may be thus saved.

To show the effect of a clean track, the instance may be cited of Nashville, Tenn., where the surface consists very largely of limestone rock. The writer has several times made careful note of the station output before and during a sudden heavy shower.

A reduction of from 900 to 600 amperes, or more than 30 per cent., was actually observed.

Probably the greatest effect will be felt in towns where the streets are unpaved and the travel is heavy enough to keep the rails continually covered with dirt.

THE EXPERIENCE OF CITIES WITH THE TROLLEY SYSTEM.

BY

S. W. Balch

The citizens of Yonkers have recently been discussing at much length the advisability of permitting the trolley system in their city, and the city council have finally decided to permit its use with certain restrictions. In connection with this discussion, one of the enterprising papers of the city, the Yonkers *Daily Herald*, addressed a number of inquiries concerning the trolley to the mayors of 108 cities in which it was understood to be in operation. Replies have thus far been received from 66 cities and towns. Sixty-two show a practical experience with the system and are, therefore, noted in the answers below.

The first question put to the mayors was as follows: "Do you consider that the trolley system has been operated successfully in your city?" All but five answer this in the affirmative. Three report that it is fairly successful, and two say that it has not succeeded.

The second inquires if the fault is believed to be in the system or in the management. From Toledo, O., where the Thomson-Houston and Westinghouse systems are used the answer considers the fault about equally divided. Zanesville, O., reports that good management is everything. Ottawa, Ill., reports that the management is a little lame. Akron, O., and South Bend, Ind., say that the electric cars are not a success on account of the management.

The mayor of Rockford, Ill., considers all overhead wire business bad and hopes that Edison will make a success of his two-track idea. He also remarks that the system is good when well carried out with double motor cars, revolving snow-brushes and heavy rails, and lays the faults to cheap equipment. Camden, N. J., reported that their system was not successful at first because the power generators were not suitable.

The third question inquired whether the system had benefited the business interests of the city. This question is answered affirmatively, and in many instances with emphasis, by all except South Bend, Ind., in which the answer to the question is omitted, and Buffalo, N. Y., where the use has not been sufficient to warrant an opinion. The mayor of Wilmington, Del., reports that the electric cars have infused new life into the people, and that a horse is too good an animal to put to a street car. The city electrician at Springfield, Ill., reports that there is a car every 15 minutes for those who live five miles from the centre of the city and that the great beauty is that the cars are on time.

The fourth question asks, Which system is used? As many cities use more than one system, or combinations of two or more systems it will, therefore, be seen why the numbers here given will sum up more than the number of replies which have been sent in. In 12 replies no answer, or an indefinite answer, is given to the question. From the others it appears that they are in use in, and endorsed as good by, the following places :—

	Used by	Approved by
Thomson-Houston..........	31	24
Sprague-Edison......	24	17
Westinghouse.......	5	4
Short.....	3	2
Van Depoele........	1	1
Detroit Electrical Works..........	1	1
Daft..............................	2	0

The fifth question asked the mayors if they consider their system the best. Their replies are incorporated in the above table, but as each appears to be contented with the system which he happens to have, his opinion does not appear to be much of an indication as to which one is the best. In several instances where two systems are used both are endorsed without preference. The mayors of Milwaukee, Quincy, Mass., and Reading, Pa., make no choice between the Thomson-Houston and the Sprague. On the other hand the mayor of Marlboro, Mass., has the latter but prefers the former. The Thomson-Houston system is also especially endorsed by the mayor of Peoria, Ill., and the city electrician of Springfield, Ill. The Sprague and Edison systems are endorsed by the mayor of Canton, O., and the Sprague and Westinghouse systems by the mayor of Wilmington, Del. The mayor of Lancaster, Pa., prefers the Edison to the Daft system.

The sixth question inquired if any persons had been killed by the electric current from the trolley line, and the seventh, how many. These are answered in the negative in every reply but one. This one is from Louisville, Ky., and reports five or six killed by carelessness of passengers. It is not thought from the answer that they were killed by the current. In Canton, O., a little girl was run over. Toledo, O., mentions two injuries. The mayor of Lynn, Mass., mentions accidents to carriages being run into, and Zanesville, O., reports the killing of several dogs. A number report no accident of any kind.

The eighth question asked if accidents from the current were very likely to happen. This was answered unqualifiedly in the negative in 40 of the replies, and no affirmative answer was received. The city electrician of Springfield, Ill., says : "On three occasions I have seen the entire current (480 to 510 volts) pass through a man. Of course he was burned but was at work again in 48 hours. Such cases as these are due wholly to the carelessness of the men while repairing hooks." Streator, Ill., reports that the current has been taken without injury. Johnstown, Pa., answers, "No, the current is not over 500 volts." And Camden, N. J., replies that the voltage is 220 and that fatal accidents are not looked for. The mayor of Milwaukee thinks an accident is possible upon contact with a live wire.

The mayors of several cities referred to their experts for the information sought. Saginaw, Mich., referred to W. J. Hart; Salem, O., to W. H. Wheldey, and Springfield' Ill., answered through Edgar L. Gross, city electrician.

The mayor of Aurora, Ill., sent a very interesting reply, of which the following is an abstract: "We have an elaborate and costly system of street railway propelled by the trolley system, and it operates successfully save when a snowstorm shuts it off short. Nobody has been killed by the electric current, but we have had some narrow escapes from death. Telephone wires are liable to break, and if they fall across the trolley wire it will kindle a fire in the office or residence, a mile away perhaps. One of the trolley wires fell recently in this city and knocked a horse down. If you are about to insert the trolley system, I suggest that you require the company to light the streets which it occupies without charge, placing a lamp on every second or third pole. The city of Providence, R. I., has been considering the granting of a franchise to a street railway company, and I recommend that you send to the Hon. H. Howard of that city for a copy of the pamphlet publication No. 8, of the Advance Club of Providence. It contains the contract which the city of Toronto has with its street railway company, which has many safeguards. The rate of speed should be regulated from time to time by the city authorities, and the company should be held to a rigid accountability for the condition of the street and road-bed which it occupies. A city should prepare its own ordinance granting the franchise, for if prepared by the company they will get the best of you and gain many little advantages by cunningly devised phrases which will hardly be apparent upon casual reading."

The mayor of Allentown, Pa., says that he considers the T rail better than the flange rail in every particular if wagon gauge is not required.

THE LAW OF MOTOR EFFICIENCY.

BY

C O Mailloux.

In the issue of The Electrical Engineer of December 16, Mr. H. Ward Leonard attempts to set aside my objections to his so-called law of motor efficiency. I will encroach upon your valuable space once again, not so much for the purpose of further argument with Mr. Leonard, as of straightening out certain questions of fact on which he does not appear to be as well informed as he might be. Mr. Leonard's statements, in fact, tend to strengthen the impression that he has neglected not only the theory but even the history of the "art to which his invention appertains."

It was in 1882 that Marcel Deprez first accomplished what Mr. Leonard now claims as his discovery or invention. He described his method in *La Lumière Electrique* (Oct. 3, 1885, pp. 6, 7). His experimentss have been freely quoted, among others, by Kapp, (Elect. Transm. 3d Ed., p. 89) ; and also repeated by others, (Thompson Dyn. Elec. Mach., 3d Ed., p. 539).

M. Deprez took a motor which was loaded artificially so as to give a constant moment of resistance, and consequently requiring a constant torque to make it turn. He applied to this motor a source of E. M. F. which he caused to vary from zero up to an extreme limit. He found that for any given load the current increased until it was sufficient to produce the torque needed to start the motor. Any further increase of the E. M. F. caused the speed (and therefore the counter E. M. F. of the motor) to increase so as to prevent the current from rising above the value at which the motor began to turn. He laid down and proved the law that for any load (torque) a certain current is required, and that this current will *automatically* be maintained constant, or very nearly so, at any and all speeds, it being independent of the speed. He also showed that the speed was controlled and governed for a given load, entirely by varying the E. M. F. of the source of supply.

In the original experiment the E. M. F. was regulated partly by varying the speed of the dynamo, and partly by a variable resistance in the circuit. He described later (Oct. 17, '85) a method of varying the E. M. F. of a generator (or motor) run at constant speed, by varying its magnetic field, which is the method of E. M. F. regulation found in Mr. Leonard's method.

Even the plan of separately exciting the motor was first made known and used by Deprez. It requires no extended comparison to see that M. Deprez's method accomplished all that Mr. Leonard's does and by exactly the same means, namely, by varying the E. M. F. of the source of supply. The only difference exists in the details and in the *theory*. Although Mr. Leonard effects his regulation solely by varying the E. M. F. of the source of supply just as M. Deprez did, yet he claims to have some control on the amperes, while M. Deprez made no such claim, but on the contrary recognized and admitted the fact that the amperes do and will control and take care of themselves automatically. The fact that the efficiency is more nearly constant when the E. M. F. is varied with the speed of a motor run at constant torque, has also not escaped attention. The table of tests of a ½ h. p. Immisch motor, quoted by Thompson, (Dynam. Elec. Mach., 3d Ed., p. 562) gives a sufficiently clear indication of it. Every one who has had experience with storage battery cars wherein the speed regulation is effected by grouping or varying the cells, has doubtless observed the fact. The present writer has many records of brake tests made in 1887, and subsequently, which show this very clearly.

In a later portion of his discussion in the same journal, M. Deprez gives (Oct. 24, '85, p. 158) an equation of efficiency which is an extension of that which I gave in my previous article, and which Mr. Leonard may find of interest.

According to M. Deprez, the efficiency depends on three things *only*: 1. The speed of the motor, *i. e.*, the counter E. M. F. 2. The ratio of the total circuit resistance to the motor resistance. 3. The ratio of the watts spent in heating the motor to the torque obtained by the current—which is what he calls the "cost of the torque."

These statements can be made to embrace almost any case of electric power transmission. The conditions and the rule which I gave for obtaining maximum efficiency are in harmony with M. Deprez's views.

So much for the facts as to the novelty of the method or the accuracy of the "law." Let us now see what are the facts in relation to the question of torque in the street car motors commonly used, *i. e.*, in plain series motors.

I quote :—"Mr. Mailloux is, I think, in error in stating that in the street car motors commonly in use the amperes vary as the torque. Such a condition could only be realized in a constant field and with the series field commonly in use, as a constant field is not realized under varying torques, although the commutation of the field is, of course, an endeavor to approximate to it."

The fact is that the amperes vary as the torque in all forms of motors, though not in the same way. In a shunt motor the curve of torque is nearly a straight line; in a series motor it is convex toward the axis of amperes, for the lower values. In both cases, for higher current values the line is either straight or slightly concave to the axis of amperes. The physical or mathematical reasons do not interest us now.

It is sufficient to know that the amperes do vary as the torque in series motors. For medium and high current values the series motor has the great advantage that it requires less amperes per unit of torque than does the shunt motor, and is not so likely to spark, because its load is constant, while that of the shunt motor will change with the current.

I do not regard a constant field as a condition *sine qua non* for accomplishing what Mr. Leonard's method does. A series motor used in place of his separately excited motor would operate quite as satisfactorily in most cases, and more so, in many cases. Mr. Leonard insists that when he groups the six motors in different ways, he varies the volts as the speed desired. Until his explanation is made intelligible however, or a more logical one substituted therefor, I must adhere to my previous opinion.

Mr. Leonard has also permitted himself to make the absurd statement that "there is no question that the current *will* be constant for all groupings, neglecting, of course, the slight effect of the losses in heat, etc." No question admits of more easy demonstration. In the abstract, one might ask, if the current is the same for all groupings, then since the direct E. M. F. is also constant, the electrical energy abstracted from the circuit, is constant. Where then would the energy come from which causes the increase of speed? In point of fact it must and does come from increase of current. Let us take a concrete case by assuming that each car requires for keeping it in motion on a given grade that the motors should each develop 200 pound-feet of torque or 1,200 pound-feet for the three cars constituting the train. This torque will, it is evident, be the same, at all speeds usually employed. Hence, each motor must furnish the same torque, no matter at what speed it runs, so long as the load and the grade remain the same. Starting with the six motors in series, a given current, say, 15 amperes is required to produce in each motor the desired torque of 200 pound-feet.

Let us now connect the six motors in two multiple series of three. Each series will again take 15 amperes to give the same torque. The line current will therefore be 30 amperes. If we connect the motors in three multiple series of two, the line current will be 45 amperes; with all the motors in parallel the current will be 90 amperes. The electrical energy supplied to the train, and, in consequence, the speed, will of course increase at each change in grouping. The change of speed will, in most series railway motors, cause a further complication from the fact that the same current will not maintain quite the same useful torque at all speeds, partly owing to changes in the coefficient of friction, and partly to armature reactions. For a given torque the current must be increased slightly as the speed increases. Mr. Leonard's emphatic statement is therefore without foundation. He has apparently confounded this case with one in which the motors remain always connected the same way.

Lastly Mr. Leonard's explanation of my abhorrence of commutators also falls to the ground, in view of the fact that in the method proposed by me the sparking was entirely obviated. There was also no rheostat. The voltage of the dynamo side of the converter was not expected to exceed at any time 25 volts for the function it was to perform. Its output would not exceed 2,000 watts at any time.

As for the question of weight, if Mr. Leonard can really make with 500 pounds of material a motor dynamo, having two distinct fields, of the watt capacity stated in his article, and running at reasonable speeds, and fair efficiency, he has done something that will produce a far greater and more lasting impression than his so-called "law" of efficiency.

RATHITE.

RATHITE is a new insulating compound, composed of vulcanized india-rubber and silk fibre. The idea is to apply this form of insulation in all cases where solidity rather than flexibility is wanted. The compound is due to MM. Waddington, Rath et Cie.

AN ELECTRICIAN'S APPEAL TO PORCELAIN MANUFACTURERS.

The subjoined appeal to porcelain manufacturers is from Mr. Francis W. Jones, the well-known electrical engineer and inventor, and now electrician of the Postal Telegraph-Cable Co., of this city. What Mr. Jones says on the matter of insulators is not only important but true, and it does seem to us that American porcelain manufacturers should have no difficulty in meeting the demand. It should certainly be worth their while, as the insulators used by the Western Union and Postal companies alone must run up into millions, with a steady consumption every year:

To the Porcelain Manufacturers of America:

Up to the present time in this country, glass has been chiefly used for the insulation of telegraph lines. In Europe, however, porcelain is the prevailing material and presents three or four times more resistance to the leakage of current than glass. The great cost of importation under a high tariff, coupled with a lack of knowledge of the advantages gained in Europe by the use of porcelain, are undoubtedly the reasons why glass has been so long adhered to in America, notwithstanding that great loss of business occurs during rains and fogs by the electricity leaking down the poles, rendering the wires inoperative. The insulating properties of porcelain depend on its quality. It requires a good smooth surface, must be perfectly vitrified throughout so as to be homogeneous, impervious to moisture and free from flaws; the glaze must be good. If such an article can be produced in this country, it sooner or later undoubtedly will replace all the glass in use, even should quite a difference in price exist in favor of glass. It would be an advantage if the shape could be made to conform to the present double-petticoat glass, but it may be thought best to adopt the English Post Office pattern. To convince you of the soundness of my views, see F. L. Pope's 1891 edition of "Modern Practice of the Telegraph," page 115. Also Preece & Sivewright's last edition on "Telegraph," page 267. Mr. Preece is electrician of the British postal lines. You will feel convinced, I am sure, that a field is open for your careful consideration and action. I shall be pleased to hear from you further on this (to me) important subject.

F. W. Jones, Electrician.

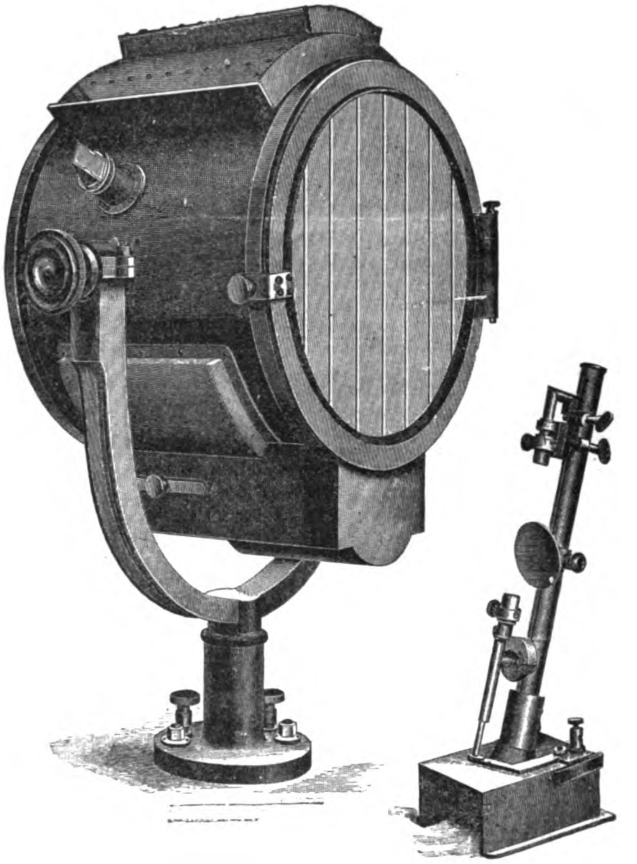
Postal Telegraph-Cable Company,
New York, Jan. 5, 1892.

THE ELECTRIC LAUNCH "ZURICH."

The following particulars from *L'Electricien* with regard to the electric launch, "Zurich," which attracted much attention at the recent Frankfort Exhibition, may be of some interest. The launch was constructed by MM. Escher, Wyss et Cie., of Zurich, and the Oerlikon Maschinenfabrik. The hull was of steel, and the boat was capable of carrying 100 passengers. The dimensions were: Length, 53 ft.; beam, 10¼; mean draught, 3½ ft. The screw, which was 28 in. in diameter, was coupled direct to a 10 h. p. two-pole Brown dynamo run as a motor at 350 revolutions. Power was supplied by a battery of 56 Schoop 31-plate gelatinous accumulators, having a capacity of of 450 ampere hours, and a maximum discharge current of 80 amperes, and weighing in all about 5 tons. The total weight of the electrical equipment was 6½ tons, that of the boat being 15 tons. The motor, when running at 365 revolutions, and absorbing 10 h. p. (102 volts x 75 amperes), propelled the launch at the rate of 8 miles an hour; when only 8 h. p. was absorbed the speed was still 7 miles an hour.

THE THOMSON-HOUSTON SEARCH-LIGHT ON BOARD THE STEAMER "FAIRFAX."

The electric lighting plant on the steamer "Fairfax," described last week in The Electrical Engineer, is, in many respects, a model marine plant. There are 243 16 candle-power lamps in use distributed in the various parts of the ship, those in the three lower decks having water-tight fixtures. The junction boxes, 75 in number, are of bronze, and water-tight, as are also the switches, 10 in number, and the wires are lead-covered waterproof. The lamps are on nine circuits controlled by cut-outs and switches in the dynamo-room, and the mains run to four distributing boxes, conveniently located in different parts of the ship, containing the branch cut-outs and switches.



Thomson-Houston Search Light, with Focusing Lamp.

The search-light or projector, shown in the accompanying illustration, is located on the mast forward of the pilot house, and is equipped with an automatic focusing lamp. The controlling device is placed in the pilot house so that the lamp can be moved vertically and horizontally. The projector takes 20 amperes of current, and is rated at 20,000 candle power.

PROF. AYRTON.

Prof. W. E. Ayrton, F. R. S., president of the Physcal Society, at the annual meeting of the Institution of Electrical Engineers was elected to the presidential chair of that body.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns. Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XIII. NEW YORK, JANUARY 13, 1892. No. 193.

The discoveries of great men never leave us; they are immortal; they contain those immortal truths which survive the shock of empires.—Henry Thomas Buckle.

BOODY BARBARISM.

It has become a fairly well recognized fact that public improvements or the erection of large engineering works must involve, to a greater or less extent, the loss of human life, and indeed in not a few instances this consideration has been made the subject of actual calculation in advance of the undertaking of such works. We might refer to hundreds of instances in which the erection of large structures has been accompanied by loss of life, and we need go no further than to select the Brooklyn Bridge as an instance in point. We have selected this particular example in order to show the fallacy of one of the arguments, if arguments they can be called, which Mayor Boody of Brooklyn has brought forward in connection with his veto of the resolution of the Board of Aldermen granting permission for the introduction of the trolley electric railways in that city. Mayor Boody believes that while "we are called upon to yield many of our present inconveniences for the public good, no citizen in time of peace can be justly asked to hazard life and limb; no amount of material benefit can compensate for the loss of one life!" Would Mayor Boody, we would ask, see Brooklyn isolated from the world because the erection of the Brooklyn Bridge involved a loss of life or because steam boilers on ferry boats have exploded or railroad accidents have occurred? The proposition is so absurd that it needs no further discussion. But we invite Mayor Boody to bring forward a single instance in which human life has been lost due directly to the electric current from an electric railway circuit. Persons have, it is true, been run over by electric cars in the same way as they have been for many years by horse cars and steam railways; but no one dreams of stopping these valuable adjuncts of traffic and returning to the omnibus and stage-coach because people are imprudent enough to cross the tracks upon the approach of trains. Another of Mr. Boody's reasons for vetoing the resolution is that no city of the size of Brooklyn has felt justified in adopting the trolley system. Considering the fact that New York and Chicago have granted trolley privileges within their limits, this part of Mr. Boody's objection is evidently based upon a lack of knowledge; but, aside from that, the reasoning in itself is about as convincing as would be the argument that, because a town of 10,000 inhabitants had adopted a railway trolley system, the method was not adapted to one of 20,000 inhabitants.

Somewhat more than a year ago the *Daily Advertiser*, of Boston, obtained the views expressed by the mayors of a large number of cities where electric railways operated by the trolley system were in operation, and the opinion expressed almost unanimously was, that the community was largely benefited by the increased comfort due to the introduction of the electric railway, and that the advance in the taxable valuation of property was of direct benefit to the taxpayers themselves. Considering that Brooklyn has permitted the erection of many miles of elevated railways, the attitude of its present mayor is hardly consistent, and we are glad to believe that his veto will be overridden by the city council. The more recent opinions of mayors after prolonged operation of electric railways will be found on another page, on which Mr. Balch gives a résumé of the replies received to inquiries emanating from the *Herald*, of Yonkers, N. Y., in which place the subject of electric railways is now being agitated. We are convinced that if the questions involved in the introduction of the trolley system were made a proper subject of study by the mayors and councils of such cities, no difficulty would be encountered in the obtaining of suitable franchises for their introduction.

STORAGE BATTERY WORKING.

It is about a year since Prof. Ayrton and his associates published a remarkably exhaustive paper on the behavior of the storage battery during charge and discharge, in which special attention was devoted to the examination of the changes which take place in the active material during these stages, a large number of analyses being made to determine the chemical composition at short intervals. In this issue we publish an abstract of an exceedingly interesting paper read by Dr. G. H. Robertson, in which particular attention has been paid to the investigation of the condition of the acid electrolyte and its effects upon the plates during the various stages through which the cell passes in charging and discharging. He recognizes distinctly the great influence of the "active oxygen," hydrogen di-oxide and persulphuric acid, and arrives at the conclusion that for improvements in the cell we must look more to the manner of its handling than to any change in the manufacture of the plates.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.

The large number of works which have appeared during the last ten years treating of the dynamo and motor have done much to make the principles and method of construction of dynamo-electric machinery matters of common knowledge among those interested in the science. But while these books have served an excellent purpose, it cannot be denied that almost without exception they have been wanting in so far as they lacked the details necessary for the practical operation of such machines. By practical operation we mean such a knowledge of the principles of operation as will enable one to select intelligently the machine best suited for his purpose, erect and operate it in the place best adapted for it, and in a manner such as to insure its steady operation under all conditions of use. That such a treatise was needed is evidenced by the fact that several of our large electric companies issue books of instruction intended to supply the information just referred to. But none of these go as deeply into the subject as its importance warrants, and hence we are led to believe that a thorough and systematic treatise on this subject will be welcome at this time. As such we present to our readers the first instalment of the work on "The Practical Management of Dynamos and Motors," by Prof. F. B. Crocker and Dr. S. S. Wheeler. Our publication some time ago of "The Localization and Remedy of Troubles in Dynamos or Motors," by the same talented authors, which may be said to form a part of this work, has given a foretaste of that which is to come; and we thus hope to place before our readers a work which will be of the highest practical value and which will form a fitting addition to the already excellent descriptive works available on the subject of electric machinery.

BLOCK SIGNALS FOR STEAM RAILROADS.

It has taken the public a long time to become fully awakened to the full extent of the parsimonious recklessness and callous indifference to the safety of passengers which has characterized the administration of America's self-styled "greatest railroad," but the past few days have given evidence that the campaign of education is making rapid progress. If anything further were needed to give point to the scathing, if not always intelligent, criticism of the public journals, and to add fresh fuel to the flame of popular indignation, it might have been found in an article which appeared a few days since in an afternoon journal, which, for reasons not necessary to particularize, has generally been regarded as in some sense the mouthpiece of the management of the railroad in question.

This apparently inspired article informs the world that "block signals get out of order continually and lead to delays and collisions. Much better"—the writer says—"is the service of living, faithful flagmen, and *the results have shown how pre-eminently best this system is*. The block system is not worth a cent in comparison." From which profound observation we are made aware that this pretentious ignoramus does not even know what the system is, which he is so swift to condemn. He actually does not know the difference between the block system itself and the special apparatuses which are frequently, though by no means necessarily, employed in operating it. He does not know—or wilfully suppresses the fact—that the "living, faithful flagman" is never dispensed with even under the block system. He asserts that "if the whole system of the Pennsylvania Railroad were to supplant the whole system of the Central, not a train a day would be on time, and accidents would be four times more frequent than now." The all-sufficient answer to this is a comparison of the records. The Pennsylvania, with a much heavier traffic than the Central, has been operated for many years between New York and Philadelphia, under the block system, without the occurrence of a serious collision involving a passenger train, while on the Central, the actual money loss from preventable collisions south of Poughkeepsie during the same length of time, not to speak of passengers slaughtered, has been enough to equip and maintain an efficient block system twice over.

GILBERT, THOMSON, HENRY.

It is with no little pleasure that we begin in this issue a series of articles on the work of Prof. Joseph Henry, by his daughter, Miss Mary A. Henry, who proposes, and gives evidence of her ability, to prove that her distinguished father made an independent discovery of the principle of magneto-electricity. Her charming narrative goes to show not only that Henry, in this, was abreast of the immortal Faraday, but even anticipated him by several months.

Our issue this week contains also a biographical sketch of Sir William Thomson, who has just been raised to the peerage of Great Britain; and since distinction in England takes this form, the honor thus conferred upon one so thoroughly entitled to it will be noted with warm approval by every American electrician and electrical engineer—not omitting Dr. Park Benjamin, who would prefer to see the recognition take some other shape than the award of an empty title. The description given by Mr. Shaw of his visit to the great and modest Scotch philosopher is full of interest and not less so because it is timely.

But we do feel that there is some warrant for the indignant outburst of Dr. Benjamin, in our columns this week, as to the neglect shown to the memory of William Gilbert, who was at once the Henry and Faraday of his remote times, and who enjoyed consideration while alive at least equal to that which we all have long delighted to pay to Sir William, now Lord, Thomson. Why is Gilbert allowed to fall into such oblivion, or if he be remembered, why are not the memorials of his life and work preserved with as much reverence as after ages will evince for the mementos of Henry and Faraday and Thomson? We will not find fault with our English friends in this matter, for our own pages this week show that it has become a duty to vindicate the memory of Henry; but it is at least safe to say that if they do not soon take the matter up it is one that American electricians will feel constrained to be active about.

WIPING OUT THE MEMORY OF GILBERT.

BY

Park Benjamin

It seems to me that it is about time to organize in this country a "Gilbert Society" for the purpose of preventing the wiping out of the memory of William Gilbert. That task was begun by Francis Bacon probably in Gilbert's lifetime, and repeated attempts in the same direction since then have not been wanting; as witness the stupid article concerning him in the ninth edition of the Encyclopædia Britannica. I suppose that such a magnificent tribute as was paid to Gilbert by Galileo would be sufficient to keep any man's memory green even during the 17th and 18th centuries; but towards the end of the latter period despite the praises of the great Italian, some one found it necessary to make a new and peculiarly insidious attack upon Gilbert; and this I happened to unearth the other day in a rather curious way.

Pretty much everybody who has written a biographical sketch of Gilbert within the last dozen or so years has alluded to his portrait as existing in the Bodleian Library at Oxford. It is well known that that portrait was painted at the order of Gilbert himself; that it represents him in about his 48th year, and depicts him in his doctor's robes standing with his hand on the "terrella," which was his artificial earth made out of a piece of loadstone. Upon the picture and above the figure there was inscribed, first, the word "*Terrella*," then the date "1591; *ætatis* 48," and also in the background and a little below his left shoulder were the words: "*Magneticarum virtutum, primus indagator Gilbertus.*"

A couple of years ago there came into my possession an old print purporting to represent William Gilbert, and tallying in all respects with the description of the ancient portrait except in the following very significant details: The inscriptions were totally absent, and for the terrella had been substituted an ordinary terrestrial globe with the usual signs on it. As it struck me that these omissions were certainly very remarkable, and quite in line with previous efforts to slaughter Gilbert's reputation, I took occasion last September when in England, to go to Oxford for the express purpose of seeing the picture, and if possible of having a photograph made from it. I found in the Oxford stationers' stores abundant photographs of every one of the other historical portraits in the famous library, but none of Gilbert; and so I addressed a courteous request to the librarian asking permission to make the photograph in question. That gentleman in reply asked me to call upon him, which I did, and once more proffered my request, expressing at the same time the great interest which all American electricians felt in the fame and reputation of William Gilbert. He heard me through patiently, and then with a half smile, remarked:

"Well, I should be very glad indeed to allow you to photograph the picture but for one reason, which I fear must be controlling."

"And that is"—I asked.

"There isn't any picture."

As this was rather staggering in view of the repeated statements by British writers living within a hundred miles of Oxford, including various professors, I ventured to suggest that perhaps the librarian was mistaken, or was confusing the portrait in question with some one of the many others hanging in the gallery. He smiled superior once more and proposed that I walk through the room and see if I could find that portrait, which, perhaps with more zeal than politeness, I did. Then I came back to him and asked:

"Well, where is it?

"Seeing that it was removed," he answered, "over a hundred years ago, I do not know."

"Who removed it?"

"I do not know."

"Why was it removed?"

"It got decayed. It was on board, and the board rotted."

"Might I ask the source of your information?"

"Certainly," he said.

And thereupon he went to the shelves of the library and brought me a copy of the "Histories and Antiquities of the University of Oxford" by Anthony A. Wood, dated 1796, opened it at page 96 of Vol. 2, and there appeared a brief paragraph describing the picture as I have described it above, terminating with the laconic statement "Decayed and removed."

"Is there no record," I asked, "that it was ever returned?"

"None."

"Is there any receipt in the archives from anybody who took it away?"

"None."

"Has any other picture been removed from this famous collection?"

"None that I know of or have any record of."

"It is a fact, isn't it, that there are a great many pictures here of far earlier date than that of Gilbert?"

"Certainly."

"Judging by the looks of those pictures, a number of them have been restored?"

He assented.

"Well, don't you think it is remarkable that such a thing could have happened in the most conservative institution in the most conservative town in the most conservative nation in the world?"

"Very."

Then I asked him if he knew of any picture of Gilbert, and he very obligingly went to the Department of Engravings and Prints and brought me a copy which he said was of a very rare publication, but which turned out to be the same print that I had myself.

Now, it is rather a singular coincidence that the date on this print, 1796, is the same date that is on Wood's book. The print was made by a London engraver. If he did not make it from the old portrait, what did he make it from? If he did make it from the old portrait, why did he carefully leave out of his copy every word and everything which could do credit to Gilbert as the great discoverer that he was? Who allowed Gilbert's portrait to be taken from the Bodleian Library without a word of record being left behind? How did its board come to be decayed when other panel pictures did not so become? And even if it had become decayed, what was to prevent the film of paint being taken from the surface of that board, as has been done in hundreds of instances in restoring the oil paintings of the old masters, almost invariably done on panel, and remounted centuries later on canvas after their original boards had almost fallen to dust?

Gilbert, when that portrait was painted, was at the zenith of his fame as a physician. He rose to higher eminence ten years later when his book appeared. He was a graduate of Cambridge, and therefore Oxford did not hang up his portrait merely as one of its alumni, but as that of a man whom it honored itself by honoring. It cannot be said therefore that his portrait represented some one of no importance, for even when it was stolen, Gilbert's reputation was ineffably above that of dozens of the noble nincompoops and nobodies who still smirk down from those venerable walls.

So much for the past. Some time ago there was organized in England a so-called "Gilbert Society," which, we were told, was very solicitous for the fame and reputation of the discoverer. In the announcement of its establishment there appeared a long list of eminent scientists as members headed by that of the distinguished philosopher recently degraded to the English peerage. This concern was going to translate Gilbert in the highest style of the art. It has, I believe, taken subscriptions on this side of the Atlantic for its forthcoming translation. It was going to conserve and promote the memory of Gilbert. I made some inquiries while in London recently, about that society and its work, but gleaned little information. In fact, it was not easy to demonstrate its existence, although, subsequently, I was informed that it still lived, but that the preparation of its translation of Gilbert's book was not being very actively pushed; a statement that made me regret that on learning of the superior ability to be devoted to the matter abroad I had laid down the pen with my own translation of the work half finished.

Meanwhile, still pursuing my quest, it occurred to me that if I could not get a photograph of a picture of Gilbert, perhaps I might get one of his tomb; and so I sent over to a friend in London asking him if that could be done. The tomb is in the parish church in Colchester. His reply, just received, after pointing out some difficulties (the monument is high up on the church walls, there is a deficiency of light in the interior, and it will perhaps be troublesome to arrange a camera) sets forth what I suppose is the most recent attempt to blot out the memory of Gilbert; and it is a little startling. "Gilbert's memorial," writes my correspondent, "narrowly escaped destruction some time ago, when the church was in process of restoration; but our friend, Mr. Laver, a scientific man, who was then one of the church wardens, fortunately happened to see one of the workmen *wheeling the monument off in a barrow* and rescued it from demolition."

As I said in the beginning of this communication, it seems to me high time that some action, in this country, should be taken to protect the memory of William Gilbert from British depredations. *Quis custodiet custodes?*

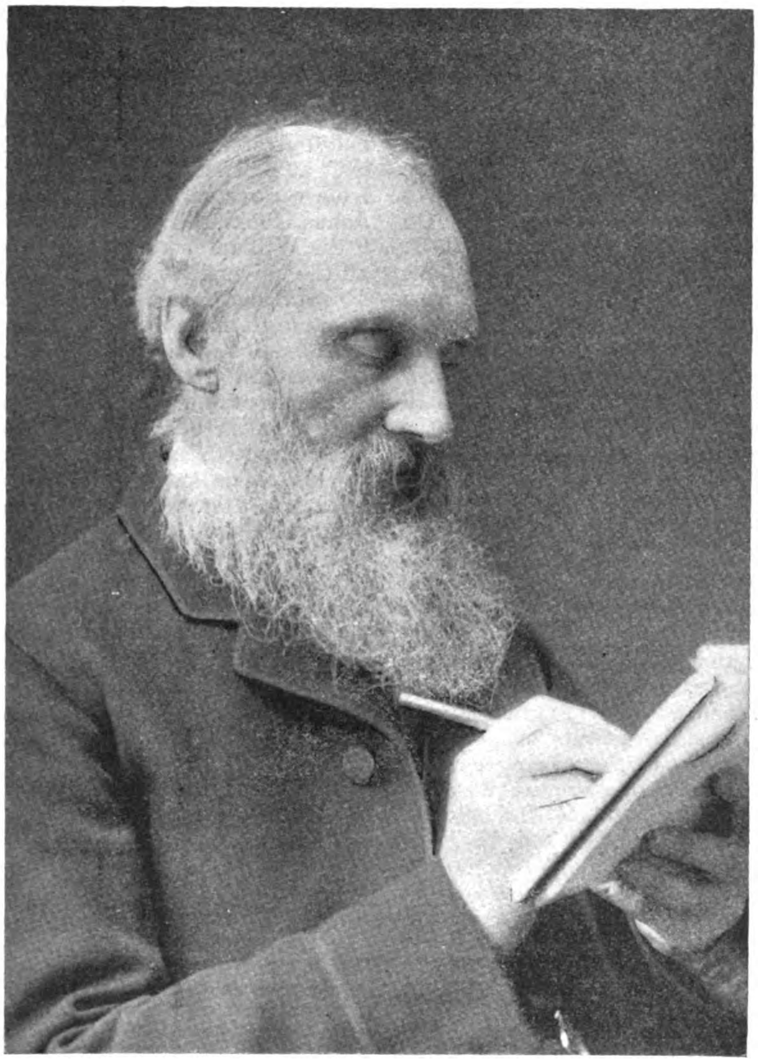
M. C. L. Weber, in an article recently published, gives the details of construction advocated for a small battery of accumulators. Two coils of lead wire, one above the other in long, thin glass tubes, is the arrangement shown. Such batteries would be used for laboratories or to charge electrometers.

WITH SIR WILLIAM THOMSON IN GLASGOW.

BY

A. C. Shaw.

The Atlantic cable has just brought to us the gratifying news that Sir William Thomson, the world-renowned electrician, has been raised to the peerage of England, and will hereafter be known to the world as Lord Thomson. Only a month or two ago Sir William was the recipient of high honor at the hands of his fellow-citizens of Glasgow, who, to commemorate the occasion of his election as president of the Royal Society, presented him with his portrait painted by the famous artist Herkomer, through the Right Honorable A. J. Balfour, then on a visit to Glasgow. At that time I had the good fortune to be sojourning in Glasgow, and had the pleasure of calling on Sir William first at his home in the University Yard, and afterwards at his laboratory, whence have come so many of those wonderful electrical instruments, which have served to win for him a world-wide reputation as the most eminent English electrician of the day, and have made his name a household word not only with scientific men, but among the people at large. Who, for instance, has not heard of the Thomson reflecting galvanometer and siphon recorder for cabling, or the sounding machine, enabling investigators to get accurate ideas of the nature of the ocean bed, or the Thomson mariner's compass, that wonderful instrument which seems to correct all errors in compass readings, and enables the mariner of to-day to make the trip from New York to Liverpool with as much accuracy as if the ship were guided on steel rails from one city to the other?



William Thomson
Glasgow Nov 28/91

It was, therefore, with feelings of profound gratification that I took the opportunity of a visit to Glasgow to call on Sir William and procure data regarding his life's history, which I now take pleasure in presenting to your readers, along with his portrait, which I may say, in passing, is an excellent likeness, and one which finds favor in Sir William's own eyes. As has been previously said, Sir William received me in his own home, in the University Yard, tendering me a hearty welcome and true Scotch hospitality. Being naturally interested in everything electrical, he then plied me with questions as to the *modus operandi* of the various systems of electric light and power in this country, being particularly interested in the wonderful and rapid development of electric street railway work. Practically there had been (with the exception of Leeds) almost no work of this kind in England, especially with the overhead trolley, and many were the pertinent questions asked as to the success and efficiency of such a system. Taking Boston for a text, and the West End Street Railway Company as an example, I assured Sir William that Americans had heartily endorsed the overhead system, and had found that electric railways were actually a necessity to the success of any enterprising city in the United States, and that though there had been severe opposition at first, the overhead wires were conceded to be much less of a necessary evil than the old antiquated horse cars. It may interest readers of THE ELECTRICAL ENGINEER to know that the city of Glasgow is at present considering seriously the question of adopting electricity as a motive power on its street railways, so that the subject was doubly interesting to Sir William at that time. On arriving at the laboratory I was presented to Dr. J. T. Bottomley, who has for so many years ably assisted Sir William, and who is himself well known to all electricians as the author of many familiar and valuable works. With Dr. Bottomley's assistance, I made a careful examination of many of the most recent inventions of Sir William, paying particular attention to his new standard electrical instruments for accurately measuring potential and current either in very small or very large quantities, and which are made by Mr. James White, of Glasgow, who has built all the Thomson instruments for the past thirty years. The most notable of these instruments are the standard direct-reading ampere balances, instruments founded on the mutual forces, discovered by Ampere, between movable and fixed portions of an electric circuit. These instruments are totally different from any other instruments in the market, and are absolutely accurate. Even more interesting than these, however, are the Thomson electrostatic voltmeters, which have the great advantage of being available as accurate measurers of potential on both direct and alternating circuits, and being electrostatic, use no current, and consequently require no temperature correction. These instruments are divided into three classes, the multicellular, the vertical and the electrostatic balance, and have a range of from 40 to 100,000 volts. It is needless to say that there were many other interesting and novel instruments to see, notably the latest invention, the Thomson wattmeter, and a variety of very large ampere-meters capable of measuring up to 100,000 amperes, without in any way heating—but I must hasten on to a short résumé of Sir William's life.

Sir William is an Irishman, by birth, though of Scotch descent, having been born in Belfast, in June, 1824. His father was educated at Glasgow University and afterwards became professor of mathematics in that college. Sir William, with his brother, James (now professor of civil engineering in Glasgow University) early took honors at the college, afterwards going up to Cambridge, where he graduated as second wrangler, in 1845, and first Smith's prizeman. At this early stage he was already noted for his success in mathematics, although other sciences had also great attraction for him, and at the same time he found leisure to devote himself to literature, music and even athletics. About this time he became interested in the study of magnetism and electricity, and gave birth to entirely new ideas on the subject of electric "potential," a subject at that time very imperfectly understood. In 1846, Thomson was elected professor of natural philosophy, in the University of Glasgow, which position he fills to-day with so much honor, having refused most tempting offers to go to English universities. In 1855 and 1856 he first gave his attention to ocean telegraphy and supplied the 1858 cable with the mirror-reflecting galvanometer, which first allowed the ocean cables to be successfully used commercially, and overcame the great difficulty of retardation. This was the first of the instruments which Sir William patented, much against his wishes, at the instigation of the Atlantic Company, as he was ready to give the public freely the fruit of his labors. Then followed the Thomson siphon recorder which was invented in 1867. This was generally brought into use three years later, and is the standard ocean cable instrument of to-day. The sounding machine and his mariner's compass were perfected about the years 1875 and 1876, and are both so well known that it is unnecessary to say anything about them. It is impossible to enumerate in this short sketch the many important points in Sir William's history, or the many useful instruments he has given to scientists, but it is interesting to note that he was in Philadelphia, in 1876, at the International Exhibition, and again in 1884 visited this country and delivered a course of lectures "On Molecular Dynamics," at Baltimore, to a class composed mainly of professors from various parts of the world, gathered together at the Johns Hopkins University.

Sir William has had honors presented to him from nearly all the universities of Europe. He is now president of the Royal Society, and ex-president of the Royal Society of Edinburgh, member of the Institut de France, the Academia dei Lincei at Rome, the Berlin Academy, the Amsterdam Koninklije Akademie and the American Academy of Sciences. He has attained almost every honor that scientific bodies can bestow on him, and, as has been already stated, has recently been recognized by the Queen by his elevation to the peerage. And yet with it all, what a modest, true-hearted, kind, genial man is there! A man whom it is an honor to meet, and yet who greets every one with a hearty frankness which at once dispels all sense of intrusion, and who inspires feelings of confidence, respect and love. Sir William, though now in his sixty-seventh year, is still as active as ever, intensely interested in all scientific work, beloved by his students, and honored by his fellow-citizens; and it is my sincere hope that he may yet be long spared to his sphere of usefulness, and the pursuit of these studies, which have yielded so much valuable fruit in the past, and which can form an ever-fruitful field of research to such penetrating genius as he so richly possesses.

SECONDARY BATTERIES.

MR. G. H. ROBERTSON'S paper, read recently before the London Society of Arts, brought out several interesting points relating to the chemistry of secondary batteries, or more particularly the chemistry of the acid, which are worth the careful study of those engaged in this specialty of electrical science. Referring to experiments with electrolytes, he says:

Although so many different modes of manufacture and preliminary treatment have been resorted to, all the batteries, so far as I am aware, which depend for their action on the couple formed between lead and lead peroxide in dilute sulphuric acid, exhibit the characteristic peculiarities noticed by Planté in his cell, namely: The high initial E. M. F. of a freshly-charged cell; the fall of E. M. F. on breaking the charging circuit, with corresponding rise on breaking the discharging circuit; the very rapid fall towards the end of discharge which occurs earlier, the more rapid the discharge is, and is not due to the exhaustion of the active material, as, after a rest, a fresh discharge can be obtained.

As the defects, namely, sulphating and buckling, which have retarded the introduction of reversible lead batteries, are also common to the two types, it appeared possible that they were due to the same causes which produced the variations in E. M. F.; therefore, as the work of Dr. Oliver Lodge[1] in 1883, and of Miesler[2] in 1888, had shown that the causes of the variation must be sought either on the lead plate or in the acid next it, and the chemistry of the plates afforded no explanation,[3] I last year, with Dr. Armstrong's advice and assistance, undertook the investigations of the reactions occurring in the acid.

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[1] Cantor lecture.

[2] "Monatshafte für Chemie," viii, 713.

[3] For references and a summary of the principal work done on the cell, see the London *Electrician*, Vol. xxvii., No. 682, p. 165; No. 692, p. 487.

In 1878 Berthelot[4] discovered persulphuric acid ($H_2 S_2 O_8$), and brought forward evidence to prove that it is the primary product of the electrolysis of sulphuric acid solutions, and that the hydrogen dioxide—which, from Faraday's time, has been well known to be present in sulphuric acid after electrolysis—is really due to the action of this body on the acid. The products of electrolysis vary with the strength of the acid, 40 per cent. acid (density 1.300) yielding practically no hydrogen dioxide; while below and above that strength it is present in varying proportions. High current density and an electro-negative condition of the electrodes favor their formation.[5] Persulphuric acid is an unstable body, and begins to decompose as soon as the current which has given rise to it is stopped, and its decomposition is accompanied by the formation of hydrogen dioxide, unless the sulphuric acid is too dilute. Hydrogen dioxide is also unstable when concentrated, but a weak sulphuric acid solution of it is comparatively stable, and the stability increases the less hydrogen dioxide it contains; therefore this body is found in estimable quantities long after the persulphuric acid which gave rise to it has disappeared. Persulphuric acid is at once decomposed by spongy metal, such as platinum black, by heat with evolution of oxygen,[6] and resembles hydrogen dioxide in these reactions, and in releasing iodine from potassium iodide, but, unlike it, has no action on permanganate of potassium or peroxide of lead. The effect of electrolyzing a sulphuric acid solution of hydrogen dioxide is simply to increase the rate of the decomposition occurring spontaneously, if a weak E. M. F. is used[7]; but on increasing the E. M. F., though the rate of decomposition is increased, a little persulphuric acid is reformed. Subsequent workers have in the main confirmed Berthelot's conclusions. To the oxidizing oxygen in the products of the electrolysis of sulphuric acid, Berthelot gave the name of "active oxygen," and as they pass one into the other, and for most purposes connected with a battery it is not necessary to discriminate between them, I have retained it.

EXPERIMENTS AT THE GENERAL POST OFFICE.

That the nature of the electrolyte affected the behavior of the cell, was evident from information received from Mr. Barber-Starkey with respect to the effect of the addition of sodium carbonate, and it seemed possible that the different behavior of cells containing this substance was due to its catalytic action on hydrogen dioxide, which is known to be exceedingly unstable in the presence of a trace of alkali; and hence a comparative study of the reactions occurring in cells containing ordinary dilute sulphuric acid, and in those which had been treated on Mr. Barber-Starkey's plan seemed likely to elucidate the causes of the sulphating during rest, and the high initial E. M. F.—the two features most affected by this treatment.

Mr. Preece most kindly aided the investigation by allowing experiments to be carried out at the General Post Office, where one-half of the secondary cells contain 1 per cent. of sodium sulphate, and the other half ordinary dilute acid, density 1.180. He also put at my disposal the records of the behavior of the cells, and they proved that there was much less sulphating with sodium sulphate, as shown by the density of the acid never falling to the same extent as in the plain cells. The following readings, taken from short-circuited cells with badly broken plates, illustrate this. In two cells containing ordinary dilute acid, the density of the electrolyte had fallen to 1.100, while, according to the last readings before the short circuit occurred, it had been 1.170 and 1.180 respectively; while in two sodium sulphate cells the density had only fallen to 1.180 from 1.200 under similar circumstances. This was strong evidence in favor of the hydrogen dioxide formed in the working of the cell being appreciable in quantity, since if sulphating were only due to local action between the support and the paste, there does not appear any reason why the addition of sodium sulphate should affect it.

Whenever the cells were tested they were always found to contain "active oxygen," which was due to the presence of persulphuric acid and peroxide of hydrogen in varying proportions. During charge, persulphuric acid is the main constituent; during discharge the quantity of hydrogen dioxide gradually increases, while in a cell which has been at rest some time, there is very little except hydrogen dioxide to be found.

In addition to the tests made on the cells in the electric light and telegraph batteries, I studied the formation of the "active oxygen" during charge and discharge on some cells which were kindly set apart for my special use. The "active oxygen" forms at once on the passage of the current, decreases slightly, and then increases to a little above its first value. Starting either charge or discharge always causes an initial increase, except in the case of cells which have been long idle, when there is a diminution, due to the decomposition of the excess of hydrogen dioxide in the acid.

To test whether electrolyzed acid was able to reduce pure peroxide of lead, two equal lots of peroxide were taken by weighing one against the other, and put in two flasks. One to each, 100 cc. of acid, from next the positive plate of a cell at full charge, was poured, and this caused the evolution of oxygen, which continued slowly for some days. At the end of a fortnight the amount of peroxide of lead in each sample was estimated, and it was found to have decreased from 97.4 per cent. to 93.94 and 94.04 per cent. respectively. This appears to explain the well-known deleterious effect of rest on a cell, for although persulphuric acid itself does not reduce peroxide of lead, it forms hydrogen dioxide on standing, which is capable either of oxidizing the lead plate to litharge or of reducing the peroxide plate to the same substance. In each case the litharge is converted into sulphate by the sulphuric acid. In an ordinary cell in good order the amount of "active oxygen" is small, varying in quantity from about 0.01 grm. to 0.02 grm. per litre; but this means that in a 45-pint cell (the size used at the Post Office) there was always sufficient to convert from 3.25 grms. to 7.5 grms. of peroxide of lead into sulphate, or to undo the work of one to two ampere-hours' charge. The figures just given do not represent the total amount of "active oxygen," since the acid absorbed by the plates cannot be tested; but as the acid has more oxidizing power, the nearer you get to whichever is the positive plate, except at the commencement of discharge, and the total quantity of "active oxygen" increases rapidly soon after breaking circuit, it seems fair to assume that this increase is due to diffusion from the plates of acid which has more oxidizing power than that in the body of cell. This increase is followed by a decrease which is rapid at first, and then gradually gets very slow, and practically ceases while there is still a fair proportion of "active oxygen" left in the cell.

In the sodium sulphate cells the amount of the oxidizing agent was usually less than in the plain cells; and the amount of hydrogen dioxide was always so, unless the battery had been at rest for some time, when the conditions were occasionally found to be reversed. This, I suppose, is due to the proportion of "active oxygen" in the form of hydrogen dioxide, at the moment of stopping the current, being greater in the plain than in the sodium sulphate cells, while the latter contain more persulphuric acid. In both cells the hydrogen dioxide present at the time of stopping the current will be reduced on the plates, sulphating the surface, and more or less screening them from further action; but, as the sodium sulphate cell contains more persulphuric acid, the subsequent formation of hydrogen dioxide will be greater in it than in the plain cell. As far as I could discover, sodium sulphate has little or no action on the acid unless it is added during electrolysis, or to acid which has just been taken from a cell through which a current is passing.

The Effects of Hydrogen Dioxide on the E. M. F. *of a Cell.*—The presence of hydrogen dioxide having been thus proved, both directly and indirectly, its effect on the E. M. F. of the cell was tested. This was done by using strips of lead packed tight into small porous pots, with peroxide of lead to represent the peroxide plates, and using plain strips as the lead plates. A solution of pure sulphuric acid, density 1.180, was used as the electrolyte. The E. M. F. of the couple was taken by the deflection method, and then a drop or two of hydrogen dioxide was added to the acid, which produced a great diminution, or even reversal, of the E. M. F. The effect of introducing hydrogen dioxide into the body of the peroxide paste was also tried with a view of reproducing, if possible, the conditions of a cell which is started discharging directly the charge is completed, and in which the "active oxygen" would be accumulated at the positive plate, leaving the lead plate free, and I found that there was a slight increase in E. M. F.

Thus the variations in E. M. F. appear to depend on which plate hydrogen dioxide is formed at. When present at the peroxide plate it causes a rise, but when diffused through the acid and present at the lead plate it causes a lowering of the E. M. F.; and the rise in E. M. F., sometimes noticed on starting the discharge of a cell which has been at rest (mentioned in Prof. Ayrton's paper, J. I. E. E., 1890, p. 572), is probably due to the electrolysis and decomposition of hydrogen dioxide, for, in a cell which has been long idle, practically the whole of the "active oxygen" is due to this body.

CONCLUSIONS.

From the same faults appearing in batteries of such different construction, and judging also from the results of the experiments recorded in this paper, it would appear that the troubles occurring in batteries are due rather to causes arising in the working than in the manufacture. What is required is some substance which can be added to the acid to check the formation of the oxidized bodies in it, which cause sulphating, without at the same time injuring the plates in other ways. Nearly all the "forming" baths which have been introduced are baths in which hydrogen dioxide would he broken up as soon as formed, and, perhaps, in some modification of them the electrolyte of the future will be found; though, since the products of the electrolysis of sulphuric acid vary with the strength of the acid and the current density, no hard and fast rule can be laid down for the treatment of cells.

In cells containing acid below density 1.200, in which the proportion of "active oxygen" existing as hydrogen dioxide is high, the addition of one per cent. of sodium sulphate, or similar substance, is likely to prove beneficial, particularly if the work of the cells is intermittent. As the strength of the acid is increased, however, and the conditions are more favorable to the stability of persulphuric acid, less hydrogen dioxide will be produced, and there is more chance of the alkali released from the sodium sulphate during electrolysis damaging the plates.

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[4] Berthelot. (*Compt. Rend.*, 90, 269–275.)
[5] Richarz. (*Ann. Phys. Chem.* [2] 31, 912.
[6] Berthelot. (*Bull. Soc. Chim.* [2], 34, 78–81.)
[7] Berthelot. (*Compt. Rend.*, 85, 8–11.)

Also, Dr. Marshall has succeeded in preparing pure persulphuric acid, and has shown this year that it forms salts with the alkalies which are very stable; and what the effect on a cell of the formation of of sodium persulphate in it would be, is quite unknown. Although the formation of peroxides in the acid does not apparently account for the great gasing and sudden loss of charge sometimes observed, still we have seen that makers are reverting to Planté's process of manufacture, or modifications of it, and we may find that in this case also he was right, and that it is to the electrolyte we must look if we wish to find the means of materially improving the lead reversible battery.

LONG-DISTANCE TRANSMISSION OF POWER BY ELECTRICITY.[1]

BY FRANCIS R. HART.

GIVEN a point were power is best obtainable and another point where such power can be most advantageously used, the problem given to the engineer for solution is that of transmitting this power from the one point to the other. If the transmitting agent is electricity, the method is called one of *electrical power transmission.*

There are two general types of electrical methods that can be employed, (1) haulage, and (2) line transmission.

The first is comparable to the haulage of coal from the mine to a distant factory, there to have its stored energy utilized in mechanical work. The skeleton of such an electrical power-transmission system is shown in the following diagram:

TABLE I.

Source of Power, { Fuel. / Water. / Wind.

Engine, { Steam-engine. / Water-engine. / Wind-engine.

Mechanical-electrical Transformers, (Dynamos).

Storage Device, (Storage batteries).

Haulage System, { Carts. / Tramway. / Boats.

Electro mechanical Transformers, (Motors).

Machinery to be Driven.

More anolagous than the haulage of coal to this method would be a compressed-air system. If the steam-engine or turbine at the source of power drove air compressors which filled portable vessels with compressed air, and these vessels were transported and attached to air engines at a distant point, we have a system directly comparable with the electrical haulage plant.

The storage battery street car is an example of this method of electrical power transmission.

The other general type of electrical methods for distant delivery of power employs a line of conducting wires between dynamo and motor in place of the cumbersome system of haulage.

The second system has obvious advantages for long-distance transmission and I shall consider with you that only. There are conditions, however, where even for other than tramway work the haulage system may be the only or best system that can be employed.

I have given *fuel*, *water* and *wind* as the three power sources which may be employed to drive a power system. Some of the uses to which electrical methods of transmitting power may be put are shown in the following table:

Steam:
1. Large number small users obtain more economical power from one engine.
2. Local distribution from lighting companies.
3. Street railways.
4. To replace long shafts.
5. Special works (mines, etc.).

Water:
1. Locate mill with reference to shipping conveniences.
2. Concentration of small water-powers.
3. Carrying power into cities for factories, street railways, etc.
4. Continuous use of power (power during day and lighting at night).

Wind:
1. Pumping (mines and irrigation); wind-engine at best point and pump anywhere.
2. Lighting with storage cells.

The skeleton of the system is as follows:

Source of Power, { Fuel. / Water. / Wind.

Engine, { Steam-engine. / Water-engine. / Wind-engine.

Mechanical-electrical Transformers, (Dynamos).

Conducting Wires.

Electro-mechanical Transformers, (Motors).

Machinery to be Driven.

In practice, except for street railway and mining work, fuel is not an economical source of power for long-distance transmission plants. Ordinarily it is cheaper to deliver the coal at the distant point and obtain the power directly. In connection, however, with water-power the usefulness of an electrical power system can hardly be exaggerated.

Before describing to you the various systems that can be employed for line electrical power transmission I wish to call your attention to certain points concerning the efficiency of such a method and how far we can govern this efficiency. We call the mechanical efficiency of a system the ratio of the power delivered to the dynamo-electric machines at one end of the line to the power delivered by the electric motors at the distant end.

The commercial efficiency of a dynamo or motor, as I shall show you later, varies with its load. The maximum efficiency of good machines should not be under 90 per cent. and is seldom above 92 per cent. Under the most favorable conditions, then, we must expect a loss of, say, 9 per cent. in the dynamo and 9 per cent. in the motor.

The loss in transmission, due to fall in electrical pressure or "drop" in the line, is governed by the size of the wires, the other conditions remaining the same.

For a long-distance transmission plant this will vary from 5 per cent. upwards.

With a loss of 5 per cent. in the line the total efficiency of transmission will be slightly under 79 per cent.

With a loss of 10 per cent. in the line the efficiency would be slightly under 75 per cent. We may call 80 per cent. the practical limit of the efficiency with the apparatus of to-day.

The methods for long-distance power transmission by electricity may be divided into three general classes: (1) Those using continuous current; (2) those using alternating current; and (3) regenerating or "motor-dynamo" systems.

I have tabulated the subdivisions of each of these general classes as follows:

- Continuous current.
  - 2-wire.
    - Low voltage.
      - One machine.
      - Machines in parallel.
    - High voltage.
      - One machine.
      - Machines in parallel.
      - Machines in series.
  - 3-wire
    - 2 machines in series.
    - Machines in multiple-series.
  - Multiple-wire
    - Machines in series.

- Alternating current.
  - Alternating single phase.
    - Without conversions (1).
    - With conversions (2).
  - Alternating multi-phase.
    - Without conversions.
    - With conversions.

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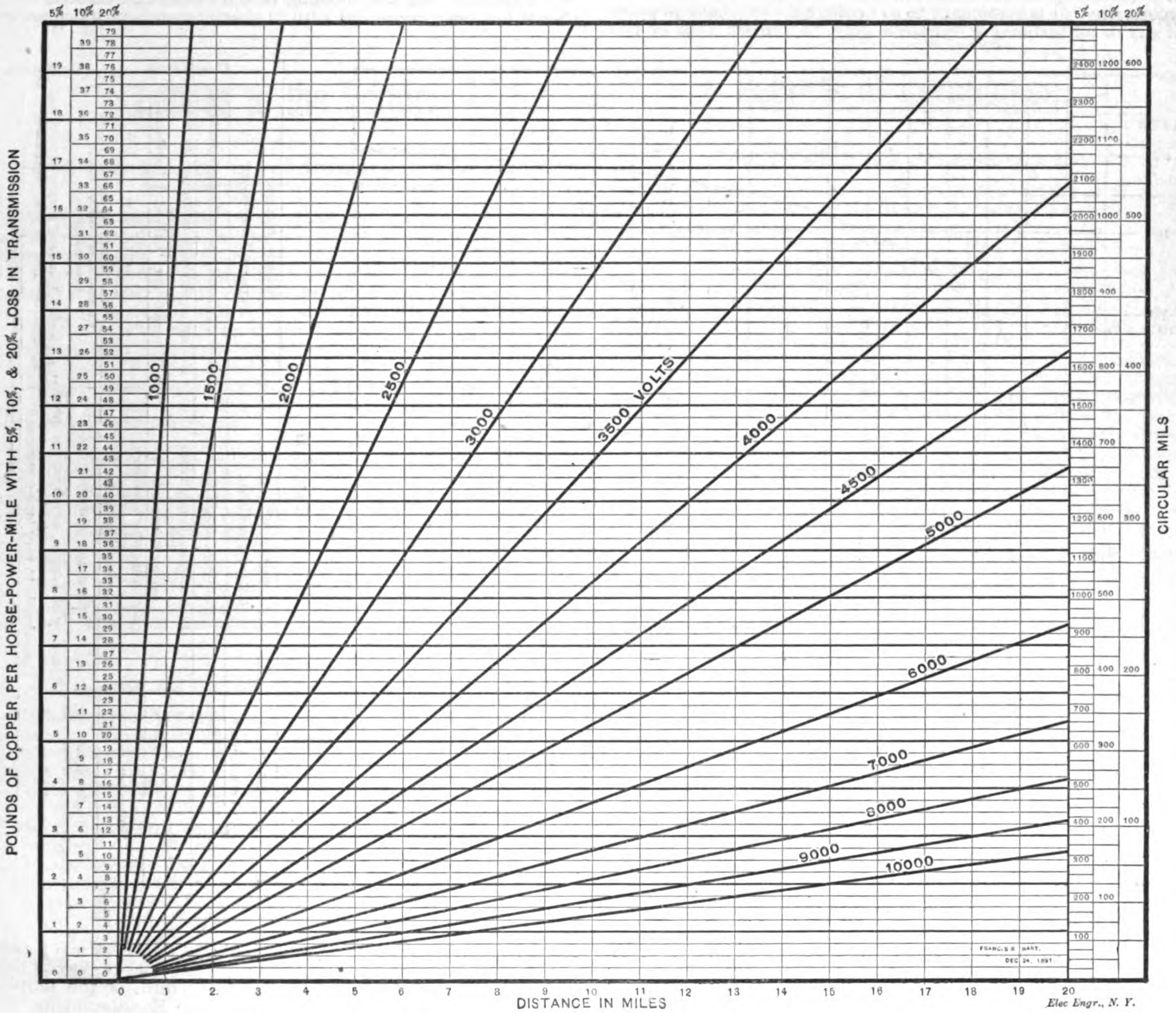
[1] A paper read before the Society of Arts, Boston, December 29, 1891.

Regenerating systems.
- **Alternating-continuous.**
- **Alternating converter; line converter; alternating-continuous.**
- **Continuous-continuous.**
- **Partial reconversion of any system.**

The relative advantages of these systems vary with each particular transmission problem, but in a general way may be tabulated as follows:

The system selected must (1) fill construction and operation conditions, and (2) give minimum cost per horse-power delivered. There are many factors which govern the selection of a system. For each problem considered there will be found certain fixed and certain unfixed conditions.

In general the fixed factors are as shown in Table II.



Elec Engr., N. Y.

FIG. 1.

1. Capacity of source of power; 2. Cost of power at source; 3. Cost of power by other means at point of delivery; 4. Danger considerations at motors; 5. Operation conditions; 6. Construction conditions, (length of line, character of country, etc.)

The partly fixed conditions are:

7. Power which must be delivered (*i. e.*, the efficiency of the system). 8. Size and number of delivery units.

The variable conditions are:

9. Initial voltage; 10. Pounds of copper on line; 11. Original cost of all apparatus and construction; 12. Expenses, operating: (Fixed charges, interest, depreciation, taxes, insurance, etc.) 13. Liability of trouble and stoppages; 14. Danger at station and on line; 15. Convenience in operating, making changes, extensions, etc.

Assuming that the cost of dynamos, motors, etc., will be approximately the same whatever the initial pressure, I shall show you the great variation in the cost of wire at different pressures. For convenience in working out such problems for rapid and approximate determinations, I have drawn a diagram on chart, Fig. 1, from which can be determined the pounds of copper required for transmitting any number of horse-power from one to twenty miles with an initial pressure of from 1,000 to 10,000 volts, at various losses in transmission. The scale of ordinates on the left gives the total pounds of copper required for one horse-power for each mile transmitted at 5 per cent., 10 per cent. and 20 per cent. loss in transmission. The scale of ordinates on the right gives the area in circular-mils of one of the two necessary wires at the same percentage losses.

To illustrate the use of the diagram, suppose we wish to know the weights of copper required for transmitting 100 h. p. 5 miles at 2,000, 3,000, and 10,000 volts and at 10 per cent. and 20 per cent. loss respectively. By inspection of the diagram we obtain the following figures.

Voltage.	Drop.	Total Pounds Copper.
2,000	10 per cent	33.6 × 100 × 5 = 16,800
	20 per cent.	16.8 × 100 × 5 = 8,400
3,000	10 per cent.	14.8 × 100 × 5 = 7,400
	20 per cent.	7.4 × 100 × 5 = 3,700
10,000	10 per cent.	1.24 × 100 × 5 = 620
	20 per cent.	.62 × 100 × 5 = 310

Very interesting mathematical deductions can be made showing conditions which give minimum cost, maximum efficiency, etc., but in practice these become of small value as almost invariably there are fixed construction or operation conditions which cannot enter as factors in a derived formula.

In the limited time left to me I can do no more than indicate to you the details of the construction and operation of an electrical power plant. I shall take as an example an installation where the source of power is water. We may separate the details of construction and operation into four heads—hydraulic, mechanical, electrical and financial. Under "hydraulic" come the improvement, control and care of the water privilege; the selection, placing and care of turbines, and the turbine regulation.

A good turbine, working at its proper load, will deliver from seventy-five to eighty per cent. of the total energy of the water. If over or under-loaded to any extent the efficiency is diminished. For the most efficient and economical working of a plant it is therefore necessary to exercise care and judgment in the management of the turbines.

Under the head of "mechanical" details of construction and operation belong the selection and care of shafting, gears, belts, clutches, etc. It is customary to so arrange the mechanical parts that any or all turbines or dynamos may be thrown into or out of use without affecting the running of the plant. That is, where possible, all like units should be interchangeable without interfering with the operation of the plant.

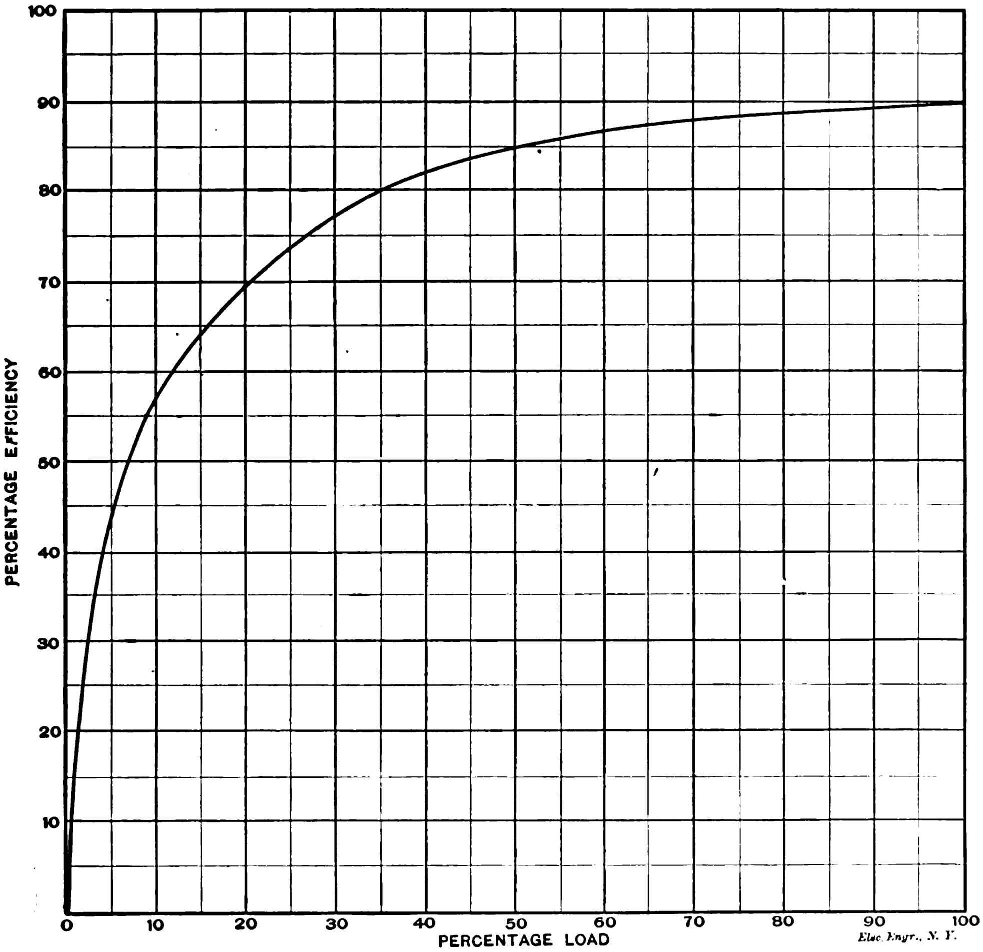


FIG. 2.

Under the head of "electrical" we have: Line construction and maintenance; machine construction, installation and maintenance; construction of switchboard, selection, construction and care of measuring instruments, lightning arresters, etc.; provision for extra parts of machinery and conveniences for rapidly making necessary changes.

The same care exercised in keeping the turbines at maximum efficiency should be applied to the dynamos. The curve, Fig. 2, shows the average variation in efficiency with load of dynamo-electric machines of from 25 h. p. to 75 h. p.

In all such plants complete records, in the form of daily reports, should be kept of pressures, currents, speeds, heights of water, time machines are started and stopped, etc. A monthly statement should be made showing the averages of the daily reports and all expenses for the month. It is convenient to deduce from each monthly statement for a uniform basis of comparison, the cost per horse power delivered for a stated time.

As the chairman, Prof. Cross, so kindly referred to the transmission plant at Cumberland Mills (Maine), which was designed and installed by the Massachusetts Electrical Engineering Company, a brief description of that plant may be of interest. The source of power is the Piesmuscot River. The turbines are vertical "Hercules" wheels working under a head of 12 feet. There are five eighty-horse-power dynamos at Saccarappa, and one mile away, at Cumberland Mills, are six motors, delivering power to the paper mills. The system is three-wire, with a maximum pressure of about eleven hundred volts. The wires are bare copper, with a sectional area each of 167,805 circular mils.

TABLE II.

	System.	Advantages.	Disadvantages.
Continuous.	2-wire { Low voltage.	Safety, simplicity.	Expense for copper.
	2-wire { High voltage.	Economy, simplicity.	Danger, difficulty of building machines.
	3-wire	Low voltage on machines and saving in copper.	Not saving enough in copper for long distances. Necessity for "balanc'd" system.
	Multiple-wire.	Low voltage at machines and saving in copper.	" " " "
Alternating.	Single phase.	Economy of copper.	Cannot start under load. Low efficiency.
	Multiphase.	Economy of copper, synchronous speed unnecessary, applicable to very long distances.	Complexity. Lower efficiency of terminal apparatus. Not as yet "standard."
	Motor-dynamo.	High voltage transmission. Low voltage delivery.	Expensive Low efficiency.

Society and Club Notes.

PITTSBURGH ELECTRIC CLUB.

AT the first regular meeting of the Pittsburgh Electric Club, after it had been organized with 71 charter members, officers were elected as follows: Morris W. Mead, chief of the Electrical Bureau of Pittsburgh, president; Eugene Ingold, of the Fort Wayne Electric Co., vice-president; James A. Rutherford, of the Railway Department, Westinghouse Electric and Manufacturing Co., treasurer; J. E. Hall, of the Fort Wayne Electric Co., secretary. H. McL. Harding and Ph. Lange, of the Westinghouse Co., E. B. Gawthrop and D. W. Dunn, of the Thomson-Houston Co., Isaac A. Silverman and E. B. Kettle, of the Edison Co., and W. N. Dillon, of the Brush Co., were elected a board of directors.

The club house is situated at 802 Penn avenue, in the very heart of the down-town portion of the city. It is equi-distant from all the railroad depots, and easily reached from any hotel. The building itself is three stories high, furnished throughout with antique oak. On the ground floor are two reception-rooms connected by a double folding door. In the rear of these rooms are the buffet, the dining-room, and the steward's quarters. On the second floor are the billiard-room, card-room and reading room, while on the third floor are three bedrooms. The place is fitted throughout with all the modern conveniences of a first-class club house.

The reception on the first of January was attended by about 500 people, and was a most enjoyable affair.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The sixty-third meeting of the American Institute of Electrical Engineers will be held at the headquarters, 12 West Thirty-first street, New York, Tuesday evening, January 19th. A paper will be read by Mr. Chas. P. Steinmetz, of Yonkers, N. Y., on the "Law of Hysteresis." Advance copies of the paper are in preparation and will be forwarded to such members as desire them.

BUFFALO ELECTRICAL SOCIETY.

In order to increase the interest in the meetings of the Buffalo Electrical Society, and at the same time provide entertainment and instruction for its less advanced members, as well as for those more familiar with elementary branches, the Buffalo Electrical Society has taken up the study of physics as a class, devoting each alternate meeting to this purpose. Arrangements have been made for informal talks on this subject to continue through the season.

Letters to the Editor.

STANLEY AND KELLY'S ALTERNATING MOTOR—A REPLY TO MR. SWINBURNE'S CRITICISMS.

With your permission we would like to make a few remarks on the interesting comments by Mr. Swinburne in your last issue on our alternating current motor. As to hysteresis, we fail to see why this is more important in our motor than in any other in which the field is equally highly magnetized and the periodicity as great. With regard to danger from high potential we think there is none. The E. M. F. on field and condenser does not need to exceed 750 volts, and both field and condenser can be effectually protected from contact. Besides, it must be borne in mind that if through any cause a shunt were formed around either field or condenser, say, by a human body, the potential would at once fall, as the balance would be destroyed.

Mr. Swinburne's suggestion of a double-winding for the armature is another instance of his well-known sagacity and foresight. As a matter of fact, we adopted a multiple winding months ago. We are not quite prepared to enter into a detailed description of our motor yet, but not even Mr. Swinburne has foreseen the number of difficulties we have met, and we are happy to say, conquered.

W. Stanley, Jr.
John F. Kelly.

Stanley Experimental Laboratory,
Pittsfield, Mass., January 8, 1982.

IRON ROOFS FOR CENTRAL STATIONS.

Referring to the article of Mr. Alfred E. Braddell and to your editorial on same, relative to iron roofs for light and power stations, we would state that this firm has built a large number of iron roofs not only for light and power stations, but for all kinds of work. We, of course, have not seen the roofs in question, but we think Mr. Braddell will find that there is no ventilator on the roof. Any iron constructed roof which is not ventilated at the peak will "sweat" or drop water from condensation, which is due to the outside changes in the atmosphere, condensing the moisture on the inside of the roof. Any ordinary kind of a ventilator in the peak will prevent this dripping or condensation taking place. The ventilator might be made circular or it might run the whole length of the roof like a monitor and be permanently opened or have movable slats so that it can be closed when it is desired to heat the building. We know that the inner roof of wood is not only unnecessary, but would add largely to the risk of injuring the iron in case of fire.

Milliken Bros.,
(Selling Agents of the Phœnix Iron Co.)

New York, Jan. 7, 1892.

INFRINGEMENT OF RAIL BOND PATENTS.

Calling attention to an item in your paper some months since in which you stated that Chas. A. Lieb had instituted suit against the Electric Merchandise Company for infringement of patent of rail bonds, we would be pleased to have you state in the columns of your paper that Judge Blodgett has to-day rendered a decision strongly and emphatically in favor of our company and against the claims of Lieb.

Electric Merchandise Co.
W. R. Mason,
General Manager.

Chicago, Jan. 4, 1892.

Personal.

MR. M. J. SULLIVAN.

We learn that Mr. M. J. Sullivan, of this city, has been called to Chicago to attach himself to the editorial staff of the *Street Railway Gazette*. Mr. Sullivan is a young man of much promise, and in his connection with the Edison Intelligence Bureau as well as in the journalistic line, has given evidence of great energy and ability. His many friends in the East will wish him abundant success in his new field of labor. It is understood that the *Gazette* will appear henceforward as a weekly.

Messrs. George H. Guy, H. L. Webb, and C. McL. Paine have resigned from their respective positions on the editorial and business staff of *Electricity*.

Reports of Companies.

NORTH AMERICAN PHONOGRAPH CO.

The reports current during the past few weeks as to an important reorganization of the North American Phonograph Co. have taken shape in a somewhat unexpected manner. The new Board of Trustees consists of Thos. A. Edison, Samuel Insull, J. N. Bush, Thos. R. Lombard, Scott Tremaine, W. Nolan and A. O. Tate, and the officers elected are: Samuel Insull, president; T. R. Lombard, vice-president; T. Butler, treasurer, and Mr. Walcott, secretary, as before. At a meeting held January 5, to organize, an executive committee was elected of Messrs. Edison, Insull and Bush. It is evident from these events that the North American Phonograph Co. has undergone a change making it very strongly Edison in complexion and control. It is stated that the offices will soon be moved from New Jersey to the Edison building in Broad street so that Mr. Insull may give the work his personal care without interference with his duties in connection with the Edison light and power interests. Outside of Mr. Jesse Lippincott's assignees there are no large creditors except Mr. Edison and the Edison Phonograph Works, and this arrangement has been carried through with the full accord of the Lippincott interests, as evidenced by the appearance of Mr. Bush in the new management. Beyond the above facts little can be elicited at the present time as to the plans that are to be followed up or the relations that will subsist with the various sub-companies. It is understood, however, that regular business is to be resumed speedily and that the apparatus is to be actively handled.

CALENDARS FOR THE NEW YEAR.

Our friends are still sending us a fine collection of calendars for 1892, and our sanctum is rapidly assuming the appearance of an art gallery. Among those last received are the following:

The Union Metallic Cartridge Company, of Bridgeport, Conn., send a calendar of very convenient form for long-distance work. It can be used by a whole family at once.

A decidedly copper tone pervades the sky, the fields and the potatoes in the work of art furnished by another well-known house, while the two aborigines in the foreground appear thankful for something. The picture is the "Angelus," and the publishers are the Eureka Tempered Copper Company, of North East, Pa.

The Bubier Printing Company present a little cottage in a snowstorm, from which it is to be inferred that they are in it, and that the temperature will be low when they get out.

The Moss Engraving Company's calendar contains a number of excellent half-tone engravings of stage favorites of assorted styles and all ages, from Fanny Davenport to "Little Tuesday."

"You have got to take cod liver oil" is the startling announcement made by a small boy and three smaller puppies that adorn Scott's Emulsion calendar. Why?

McIlroy & Emmet publish an attractive calendar embellished with a lithographic representation of four different kinds of giggles. A little jester with a big mandolin furnishes the music.

The Direct United States Cable Company's gift is of the pad variety, with a space on each leaf for memoranda. This is mounted on a heavy board back, and is both useful and substantial. The messenger boy appears to be running.

The Pope Mfg. Co. have sent a very compact little desk pad, each page of which has a blank space for memoranda and a short note upon cycling or some kindred subject, while the day of the week and month appears at the top in sufficiently heavy type to make the whole suitable for a paper-weight.

Legal Notes.

INCANDESCENT LAMP LITIGATION—THE UNITED STATES ELECTRIC LIGHTING CO vs. THE EDISON LAMP CO.—V.

ARGUMENT OF GEORGE H. CHRISTY FOR THE UNITED STATES COMPANY.—(*Concluded.*)

Mr. Christy next considered the question of abandonment. Mere delay, he said, was not abandonment; there must have been delay of that character which showed an intention to abandon. An inventor lost nothing in filing his application by mere delay, provided no intervening rights arose which would make it inequitable to assert a monopoly as against such intervening rights. The only equitable right that anybody could acquire would be a right to use, and no such right could even begin to exist until the thing in question had become capable of that use it was intended for, to wit, commercial use. But it had been proved by witnesses on both sides, as well as by Weston, that the incandescent lamp had not reached such perfection that it could possibly have been a commercial success until late in 1880. Judge Woodruff had said—and he was a judge who had been very careful in the matter of preserving the rights of patentees who seemed to be faithful and honest in their endeavors, and he would quote his exact language—"If an inventor, without substantial reason or excuse, abandons the use of his invention, and for nine years sleeps on his rights" till others do it, etc., it must have been without substantial reason or excuse. Now was it not an excuse and a substantial reason for Weston's delay that the invention could not have been made beneficial to the public earlier than 1880, or early in 1881? Was not that fact a substantial reason for his failure to proceed? Suppose Mr. Weston had gone to the Patent Office and had got his patent in 1877. Suppose, as the record shows, that he could not have got one iota of reward, in the use or sale of the product of the patented process, until four years of the protection which the law says an inventor is entitled to were gone; or suppose the incandescent lamp had not become a commercial success until 1891, instead of 1881; under the strict rule which his brother Betts was asking his Honor to apply, 13 or 14 years of the 17-year term of his patent would have expired and he would have been without his reward. Was a man bound to be diligent to his own injury, no one else being hurt? The public could take no rights until the invention became capable of public use; hence the public could not have been injured. If it were the policy of the law, that the inventor should have a period of 17 years, at such time as he might have a reasonable chance to get therefrom his reward, then by no rule of law or of equity could Weston have been required to go to the Patent Office earlier than he had gone. Was he not entitled to his 17 years as a matter of right? Was it not the duty of the court to construe the law so as to give him that right? The courts had been careful on all occasions, to protect the rights of inventors in contingencies like that. Judge Sage had said that when an inventor had gone to the Patent Office he had thereby "committed himself irretrievably to the provision that his invention was ripe for the public." Was he bound to go any sooner? He (Mr. Christy), contended that he was not; that under the Constitution and Act of Congress, Weston was entitled to all the equities that could apply to the case, and when it appeared, as it had done in this case, by the testimony of witnesses on both sides, that this 17 years' enjoyment could not have begun to run until the latter part of 1890, then he had been entitled to wait until that time before going to the Patent Office. In support of this proposition, Mr. Christy referred to the cases of *Hubel* vs. *Dick* (28 F. R., 132), and *Railway Register Co.* vs. *North Hudson Co.* (23 F. R., 293), in the latter of which cases Judge Nixon had said that an inventor was entitled as a matter of right, to his 17 years under a valid patent. He also referred to the case of *City of Elizabeth* vs. *Nicholson Pavement Co.* (97 U. S., 126), in which Judge Bradley had said:—"His monopoly only continues for the alloted period in any event, and it is the interest of the public as well as themselves that his invention should be perfect and properly tested before a patent is granted for it." Mr. Christy said he had cited this case simply to show that the decisions of the Supreme Court had been in line with the views which he had been presenting. All the cases which had been cited by his brother Betts on the question of delay had arisen with reference to inventions capable of immediate commercial use, and hence had no application to the present case. Cases in which the invention had been made in advance of the possibility of commercial use were comparatively rare. The principle had been illustrated in the case of *McDonald* vs. *Shepard* (4 F. R., 288), and *Johnson* vs. *Root* (1 Fisher, 351). His Honor had followed substantially the same ruling in the more recent case of *Harmon* vs *Struthers*, and had gone to the extent of holding that even an imperfect embodiment of the invention would not affect the right of the inventor to his patent when he got it. Substantially identical views had been expressed by Judge Wheeler in *Campbell* vs. *The Mayor* (47 F. R., 515); a case which had been commented upon in defendant's brief and cited in complainant's brief.

Mr. Christy said he came next to what was alleged to have been the first commercial success of the incandescent lamp. It had not been Edison's nor Sawyer and Man's success. It had been the success of a man who had disclaimed the invention, and hence had no right, nor any parties holding under him, to contest this invention with Weston. Maxim had been put in interference with Sawyer and Man and had been defeated. In that interference he had disclaimed the invention of Weston, and had taken a subordinate patent; hence it appeared from the record that Maxim had no equities. Mr. Curtis had testified that the Equitable plant had been put in upon an understanding that if it worked properly and was satisfactory it should be purchased. The test had been satisfactory, and for the first time in the history of electric lighting, so far as they knew, a successful lamp had been made and put into commercial use; but that success had not dated from the first of November, 1880, by any means. It had taken a considerable time to determine whether or not the lamps would stand; he thought it doubtful whether it could have been considered a commercial success until near the first of January, 1881, if not later.

The testimony of Curtis had shown how and when it was that the United States Company, the present complainant, and Weston had come together. All the other parties whose merits had been discussed, had been engaged in the business of making incandescent lamps, or trying to; Weston's company had been engaged on dynamos, arc-lights and electro-plating machinery. Not until the complainant company had acquired a controlling interest in the Weston Company, and had taken charge of its business, had Weston found himself in a position to manufacture incandescent lamps in a commercial sense, and then he had done it. His Honor would remember this point, when dealing with the equities of the parties. The defendants had no equities in this matter and never had. They had claimed equities by reason of the acts of Sawyer and Man and of Maxim, but such acts had been adverse. Maxim had no equity as an independent inventor, because over his own signature he had disclaimed the invention now in controversy, and had made no effort to introduce it until something or other had spurred him up to it. As to the Sawyer and Man defenses, he would say in a general way, that their record had been a history, and a sad history, of efforts, defeats and failures. They had tried hard enough, but they had not succeeded. In the slang phrase of the day they "did not get there." They had admitted that they had never sold a lamp. It was not pretended by anybody that they ever had. The utmost that Brother Betts could say was that they had made one lamp and had sent it to the Patent Office. Judge Bradley apparently had not thought that the making of one lamp which had not been used, constituted prior use. Mr. Christy then read extracts from Judge Bradley's opinion in the McKeesport case (40 F. R., 21), and continued:—In view of the testimony as to Sawyer and Man, and the findings of his Honor Justice Bradley, he thought he might safely pass Sawyer and Man, for they had no equity as against Weston. They had not solved the problem; they had not made a commercially successful lamp at that time and they had not done it yet.

His brother Betts had said a good deal about Weston having kept this invention to himself; that it was very singular if he had this great invention that he had not told some one about it. That had to do not with any question of fact, but with a question of mental philosophy. But he (Mr. Christy) would say that Weston did exactly what a man exercising ordinary prudence and good business judgment might have been expected to do. He had acted wisely in keeping what he had done to himself, so far as he could. His brother Betts had said that Mr. Weston was "an expert in the use of words," and so was Mr. Quimby; but was it any discredit to a witness that he should express himself with exactness and precision? that he should be able to tell what he knows, and to stop when he got to the end of his knowledge? Was it any discredit to Quimby that when a question was asked as to which he had no recollection, that he should say so?

(Here the court adjourned to December 11, 1891, 11 A. M., at which time the hearing was resumed).

It had been alleged by defendant—continued Mr. Christy—as against Weston, that there had not been sufficient proof as to the dates which he had testified to, to come within the requirements which his brother Betts had attempted to apply to it. Where the contest was between two patents, the plaintiff owning one and the defendant the other, the rule might be as defendant had stated, and that was the case which he had stated. But as between a patentee and an infringer, no such rule had ever been applied to his knowledge, in any court in this country. No presumption of law was to be made in favor of the infringer, nor could he set up in his own behalf any title under an alleged anticipating patent not owned by him. When the complainant can rebut a prior patent by carrying back his date, he may do it, proving it by drawings, models, sketches and conversation, in any manner satisfactory to the court, as regards the truth of the things to be proven. He (Mr. Christy) knew of no case in which a court had held that the party charged with infringement was in a position to demand that proof adduced in rebuttal should come up to any higher standard than that. But whatever the standard might be, he contended that Weston met the requirement; that he had made a case, as regarded the date of invention, abundantly ample to satisfy his Honor as to the truth of the things as to which he had testified. Mr. Christy then read from copious extracts from Weston's testimony, and said he thought his Honor would agree with him that it was a story which carried on its face all the ear-marks of truth. He also read from the testimony of Broadbent and contended that it was in exact accordance in substance, if not in detail, with that of Weston. Accordance in detail might sometimes show signs of collusion between witnesses, while substantial identity as regarded substance, omitting details, was one of the best tests of the credibility of a witness. Broadbent had testified that the new laboratory was ready in December, 1877; that he distinctly remembered seeing Mr. Weston do these things in the "church laboratory" before the removal to the "new laboratory." That was the very time Weston had said that he did it; and that statement of Broadbent tallied perfectly with Weston's recollection, that it was early in 1878 that he made the removal. There were in the testimony a number of what he might have called undesigned coincidences; for example, Mr. Quimby had said that at the time he saw Weston's experiments he was engaged in reissuing some of Weston's older patents. The date of the application of the only two reissues which appear at that time, showed that they had been filed in June and July, 1877. There were a number of other unexpected and undesigned coincidences—said Mr. Christy—some which he would proceed to point out. He said that he would refer to them, not as proving anything of particular value in the case, but as showing the truthfulness of the witnesses. It was the correlation of undesigned coincidences which contributed the most convincing evidence of the substantial truth of the testimony.

Mr. Christy said that he would not take time to argue upon the well-settled principle that the first to conceive was the first inventor, provided that from the date of conception to the date of completion, he exercised reasonable diligence. He thought he could show that Weston had exercised, not merely reasonable diligence, but more than reasonable diligence. What was diligence? It was diligence in trying. If a man was exercising reasonable diligence in trying, he was doing all that the law required; all that equity required. It did not make any difference whether anybody else came in in the meantime or not. That could not affect his rights. Weston had testified that his invention, as a method of treating carbons for incandescent lamps had been completed in 1877. He thought he had shown that that was true. That he had then learned how to make a carbon conductor better, with reference to its use in a lamp. What then was there for him to exercise his diligence on from that time? Clearly it was to invent a lamp in which he could burn it; and accordingly they would find, that that was the very thing to which he had chiefly devoted his attention from that time forward.

Weston did not have a company which was trying to make incandescent lamps, as Edison and Maxim and Sawyer-Man had; his company had been engaged in other lines of business, and although it was entitled to all his inventions, he had been compelled to give the manufacturing business the preference. The matter of diligence must be judged of by the circumstances under which the diligence had to be exercised. Mr. Christy then read extracts from Mr. Weston's testimony, describing the duties which he had to perform, and the difficulties with which he had been obliged to contend. He would repeat that the diligence required was the diligence in trying, and he might add, that diligence in trying sometimes became the greater when exercised in view of unexpected and unaccountable failure. Weston had had a great deal of trouble in getting a satisfactory vacuum pump, and he had finally obtained a pump which had given him the degree of exhaustion he required from the United States Electric Lighting Company. Mr. Christy added that he had argued a good many patent cases, but he thought this was as clear and good a record of diligence as he had ever presented to his Honor, or to any other federal court. He thought Mr. Weston's rights in the matter were unassailable.

Referring to the alleged anticipation contained in the Despretz article, Mr. Christy said he would call his Honor's attention to the fact that it set forth purely a scientific experiment. Carbon was known to be one of the most refractory substances in nature, and the object which Despretz had in view was to destroy the carbon, to volatilize it, to convert it into a vapor or gas. He had used the highest possible heat he could obtain. He had run against a snag in trying to do what he was after. What was that? To volatilize carbon. Despretz says that the carbon deposited over the thread, upon the clamps, and upon the whole apparatus in the few experiments which he had made. They were all experiment, and because they had been experiments they had given nothing whatever to the practical arts, for that was the test that the courts had applied to all these things. There was no instruction there to tell a man that he could get a building-up of the carbon at the weak points, and that uniformity of resistance from one end to the other, which was the central object of Weston's invention. There had been nothing to teach a skilled electrician or anybody else that the result which this invesntion calls for could be accomplished by that experiment—for that is all it was—an experiment which had been aimed at other purposes, designed for other results, and intended to destroy the thing operated upon, and not to improve it. If there was any utility in the use of carburetted hydrogen for the treatment of carbons, Despretz had not found it out. Neither had he found out that the resistance of the carbon could be rendered uniform, nor that carbon which had been so treated was of the least value as part of an incandescent electric lamp. The Weston application had been rejected on Despretz, and had been amended after it had been held that Despretz did not anticipate. It had been amended in order to make a more accurate statement of the invention.

A fact or two in this regard; not only had the rights of Sawyer and Man in this country been reviewed by a judicial tribunal, but the significance of Despretz's experiments had also been passed upon in the courts of Great Britain.

Mr. Christy then read from a decision of Justice Butt and of Lord Justice Lindley of the Court of Appeals, and observed that while of course decisions in England were not binding on his Honor, he nevertheless thought that they were, as Judge McKinnon had once put it, "strongly persuasive of the truth of the thing decided," namely, that Despretz had not anticipated the patented process.

As to the law on the subject of use, Mr. Christy said he would refer to the case of *Colgate* vs. *Western Union Telegraph*, in which Mr. Justice Blatchford had held that even though wire had been previously covered with gutta-percha, it was not an anticipation, it not appearing that its non-conducting powers had been known under the circumstances and conditions of such prior use. As regarded the *Scientific American* articles describing the Sawyer and Man invention, he contended that they were of no higher value than the Sawyer and Man patent. They had put forth the claim of adverse right, but as Weston had anticipated them on the record, it made no difference what they had done in the meantime, especially as the record had shown, and as Judge Bradley had said, their lamp had been a failure anyhow. Ten thousand failures could not make one success.

In conclusion Mr. Christy said he would call attention to a few other points in defendant's brief. Defendant had said: "There is not the slightest evidence that the carbons of the Edison Company were of an imperfect character." Why then had they treated them? The very fact that they had treated them showed that they had been imperfect or not suitable for use, and that they had treated them to make them suitable.

Mr. Betts here observed that what he meant was that there was no proof that the carbons of the Edison Company differed in resistance at different points, not that one carbon may not have differed from another; but the point which Mr. Christy had made with regard to Despretz, that he did not show the building up of the carbon to make it of even resistance, was a good point, and if the claim had been limited to that Despretz would probably not beat it. But if it was limited to that, then he contended that there was no proof of infringement.

Mr. Christy replied that Despretz had nothing to do with the case before his Honor. If Despretz had said that he was trying to make an incandescent carbon, and if it had appeared that the only difference between Weston's carbon and Despretz' carbon was that one was stronger than the other, or that one made smoke and the other did not, then Mr. Betts' criticisms might be correct. But Despretz gave nothing whatever to the art, and hence it did not lie in defendant's mouth to say that the only differences between Despretz and Weston were differences that they did not use. Another point; defendant says—if he correctly understood his brother Betts—that the sale of a patent or the grant of a license under it was putting that invention into "public use" or "on sale" within the meaning of the statute. No decision to that effect had been cited; it was like many other legal propositions contained in defendant's brief; no judicial opinion could be found to sustain them. He asserted that neither the peddling of a patent—not the thing made under it, but the patent itself—nor the granting of licenses under it, was a working of the invention under the meaning of the act of Congress. The statute had specified four things which were patentable: first, "any new and useful art that was a process"; second, "any machine"; third, "any manufacture"—like a poker or a toothpick—and fourth, "any composition of matter." As he understood it, "public use" related to any or all of them, but more particularly to the art or process, and "on sale" related to machines, articles of manufacture and compositions of matter, which were the results, the things, the articles patented. A man could not create a public use by going round and peddling rights under his patent.

In conclusion Mr. Christy said he would submit to his Honor that all the equitable rights which he had started in to talk about belonged to the complainant; that the legal rights had come to it through Weston, and that defendant had nothing under either, and that defendant had wholly failed to show that anybody other than Weston and the parties holding under him had any legal title whatever.

Mr. W. L. Adams has been appointed secretary and treasurer of the Electric Merchandise Co., of Chicago, vice Mr. A. H. Englund, resigned.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED DECEMBER 29, 1891.

Accumulators :—

Secondary-Battery Plate, H. G. Morris and P. G. Salom, 466,138. Filed July 5, 1890.

A battery plate consisting of a compound of sulphide of lead from which is formed the spongy lead active material. A negative plate composed of a compound of sulphide and oxide of lead, and a positive plate consisting of a compound of sulphide of lead and lead peroxide.

Alarms and Signals :—

Fire or other Alarm, H. M. Browne, 465,829. Filed Dec. 24, 1890.

An alarm bell having an automatic pneumatic circuit-breaker.

Means for Transmitting Signals Electrically, T. A. Edison, 465,971. Filed May 23, 1885.

A system employing elevated induction plates for transmitting signals to distant points.

Signal-Transmitting Apparatus and System, H. A. Chase, 465,989. Filed May 4, 1891.

Has for its object to increase the efficiency and cheapen the cost of construction and maintenance of a fire-alarm system.

Signal-Transmitting Mechanism, H. A. Chase, 465,999. Filed July 10, 1891.

A signal system for use in connection with a fire-alarm system.

Electric Signaling Apparatus, F. W. Cole, 465,991. Filed Jan. 6, 1890.

Has for its object the sending of signals of different kinds to be received on any desired one of several instruments; the signal being always the same but having a different meaning according as it is received upon one or another of different instruments.

Electric Signaling Apparatus, B. J. Noyes, 466,053. Filed Nov. 4, 1890.

A multiple signal transmitting apparatus operated by a signal wheel.

Electric Annunciator, F. C. Colville, 466,063. Filed Mar. 26, 1891.

A small and compact annunciator operated with very little current.

Annunciator, W. C. Dillman, 466,159. Filed July 10, 1891.

An electric annunciator for use in connection with speaking tubes.

Electric Fire-Alarm System, H. E. Jacobs, 466,306. Filed Mar. 23, 1889.

An electric fire-alarm system comprising an electric signal, a visual signal, a thermostat and low-resistance magnet in circuit with the battery, a high-resistance magnet in shunt with said circuit, and a motor for operating said signals.

Clocks :—

Electric Pendulum Clock, H. Phillips, 466,011. Filed Mar. 11, 1891.

Conductors, Conduits and Insulators :—

Covered Electric Conductor, T. L. Reed, 465,888. Filed Nov. 18, 1890.

Insulator, G. S. Albanese, 465,961. Filed Apr. 3, 1891.

An insulator in which the line wire is held in position by a bent wire clamp on the principle of a bottle stopper.

Electric Conductor, J. W. Marsh, 466,250. Filed Sept. 30, 1890.

A conductor consisting of two wires arranged in opposite sides of a non-conducting frame and held in position by a perforated strip of fibrous material surrounding both frame and wires.

Electric Cable, W. A. Connor and J. W. Marsh, 466,268. Filed Feb. 10, 1890.

A cable consisting of a number of conductors to be used in pairs, the two wires of each pair being separated from each other by a greater distance than the adjacent wires of adjoining circuits.

Distribution :—

System of Electric Distribution, T. H. Hicks, 465,854. Filed Dec. 26, 1890.

A system of distribution for high potential alternating currents whereby the current is first reduced by a converter to the desired voltage and then changed to a continuous current.

Dynamos and Motors :—

Electric Machine, T. H. Hicks, 465,853. Filed May 9, 1890.

Provides means whereby multipolar generators can be made to furnish continuous currents of high E. M. F. without danger of short-circuiting between the sections of the commutator.

Alternating-Current Dynamo, T. H. Hicks, 465,855. Filed Jan. 3, 1891.

Employs an armature having coils arranged in pairs each coil having convolutions forming a central opening, the two coils of each pair crossing each other at the ends of the armature and occupying an arc of its circumference equal to the width of two field poles and two field spaces and extending the length of the armature.

Armature Connection for Motors or Generators, T. A. Edison, 465,970. Filed Mar. 26, 1891.

Has for its object to prevent sparking at the commutator at the instant of a break in the local circuit.

Armature for Dynamos or Motors, T. A. Edison, 465,973. Filed Mar. 23, 1891.

Claim 3 follows:

An armature for dynamos or motors consisting of a core wound with two wires said wires being connected at intervals and one of said wires only being connected to the commutator.

Alternating Current Dynamo, T. H. Hicks, 465,994. Filed Mar. 9, 1891.

Somewhat similar to No. 465,855.

Governing Device for Electric Motors, W. Baxter, Jr., 466,028. Filed Apr. 14, 1891.

Has for its object to obviate the end thrust of a governor applied to a motor shaft and to improve the bearing of the contact pieces actuated by the governor.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, S. Miller, 466,177. Filed Oct. 16, 1891.

Has for its object to provide a primary cell convenient in use, economical and very efficient in action.

Lamps and Appurtenances :—

Controlling Apparatus for Incandescent Lights, W. J. Kelly, 466,245. Filed Aug. 7, 1891.

A controlling apparatus for scenic effects in theatres, etc.

Lamp Socket, J. L. Hinds, 465,238. Filed July 23, 1891.

Has for its object the manufacture of a simple and effective socket possessing maximum efficiency and durability, and made at minimum cost.

Lamp Socket, J. L. Hinds, 466,289. Filed July 23, 1891.

Similar in its object to 466,288.

Lamp Socket, J. L. Hinds, 466,290. Filed July 23, 1891.

Similar in its object to 465,289.

Metal Working:

Sliding Clamp for Electric Welding Apparatus, H. Lemp, 465,866. Filed Jan. 19, 1891.

Art of and Apparatus for Heating Metal Articles by Electricity, E. E. Angell, 466,131. Filed Mar. 16, 1891.

Method of electrically heating metal articles preparatory to tempering.

Electric Forge. E. E. Angell, 466,132. Filed Mar. 18, 1891.

Electric Forge, E. E. Angell, 466,133. Filed Mar. 23, 1891.

Electric Heating Tool, G. W. Blanchard, 466,266. Filed April 3, 1891.

An electric heating device consisting of tongs having insulated handles and means for connecting electric conductors to their jaws, for the purpose of heating rivets etc.

Miscellaneous :—

Door Bell, F. M. Winters, 465,909. Filed June 1, 1891.

Combination of an electric door bell and clock.

A door bell operated by a small magneto-electric machine operated by the bell pull and connected with lock work which is used for ringing the bell.

Electric Cane, A. W. and A. H. Roovers, 465,949. Filed Mar. 13, 1891.

Lightning Arrester, A. Wurts, 465,958. Filed Oct. 5, 1891.

Consists of two discharge plates one of which is movable in reference to the other; these plates being so located that they will pass at the moment of a neutral point in the wave phase of the electromotive force.

Phonograph, T. A. Edison, 465,972. Filed Nov. 18, 1889.

Electrical Pyrotechnics, P. C. E. Champion, 465,981. Filed May 15, 1891.

Cut-Out, H. W. Fisher, 465,983. Filed Mar. 2, 1891.

A spring-actuated electric cut-out.

Electrical Switch, G. B. Martratt, 465,997. Filed Dec. 6, 1890.

Comination of an electric switch with a fusible cut-out.

Brake for Electric Motors, A. J. Shaw, 465,999. Filed Sept. 21, 1891.

A magnetic brake.

Electrically-Operated Elevator, F. E. Herdman, 466,037. Filed Feb. 24, 1891

Electric Plug Circuit Closer, J. L. Kimball, 466,052. Filed Jan. 22, 1891.

Has for its object to prevent the twisting of the conducting wires when the plug is screwed into its socket.

Electric Game Register for Pool Tables, C. A. Erikson, 466,068. Filed Aug. 24, 1891.

Temperature-Regulating Device for Electrical Circuits, E. Weston, 466,087. Filed June 4, 1891.

Maintains constant electrical resistance in a circuit despite changes in temperature.

Electric Switch, W. J. Kelly, 466,244. Filed June 29, 1891.

A circuit-controlling switch, simple and cheap in construction and efficient in action.

Railways and Appliances :—

Electric Railway, J. Emmner, Jr., 465,844. Filed Oct. 30, 1890.

Has for its object to simplify the construction of conduit electric railways to insure perfect contact and prevent leakage or short circuiting.

Electric Railway, H. S. Pruyn, 466,886. Filed June 25, 1890.

A strong, light elevated structure which will deaden the sound of passing trains.

Electrical Railway Switch, M. Kerstein, 466,101. Filed May 16, 1891.

An electrically actuated railway switch and means whereby it may be readily operated by the attendant on the car.

Electrically Driven Locomotive, E. H. Morgan, 466,180. Filed Mar. 9, 1891.

Method of converting an ordinary steam locomotive into one driven by electricity by the use of storage batteries.

Electric Railway Trolley and Support, W. A. Stevens, 466,196. Filed Sept 22, 1890.

Employs a top-bearing trolley wire at one side of the track.

Electric Car Brake, La M. C. Atwood, 466,212. Filed Jan. 10, 1891.

A brake actuated by a rack segment engaging a pinion on the armature shaft of the motor.

Telegraphs :—

System of Synchronism for Telegraphy, G. A. Cassagnes, 465,832. Filed June 26, 1891.

Maintains synchronism between trailers rotating on the contact distributers at two distant stations.

ELECTRICITY IN CARCINOMA.

A PAPER was read some time since before the American Electro-Therapeutic Association in Philadelphia, by Robert Newman, M. D., of this city, on the cure of cancer by electrical treatment. This paper has been published by the American Medical Press Company, of Philadelphia, and is most interesting even to a layman.

To quote the author's opening sentence: "It is a very ungrateful task to write a paper on the treatment of cancer, while pessimists insist that cancer is incurable and the profession look with suspicion on any report of a successful case, and still more hazardous to say that electricity has cured; nevertheless, it *has.*"

Dr. Newman then gives his experiences, and cites many instances to substantiate his statements, with the hope, he says, of drawing the attention of electrical experts to the subject, in order that some method of treatment may be systematized and perfected.

MR. E. E. BOYNTON, electrical engineer, has resigned his position with the Elektron M'f'g Co. of Springfield, Mass., and has entered the employ of the Thomson-Houston Electric Co., at Lynn.

TRADE NOTES AND NOVELTIES

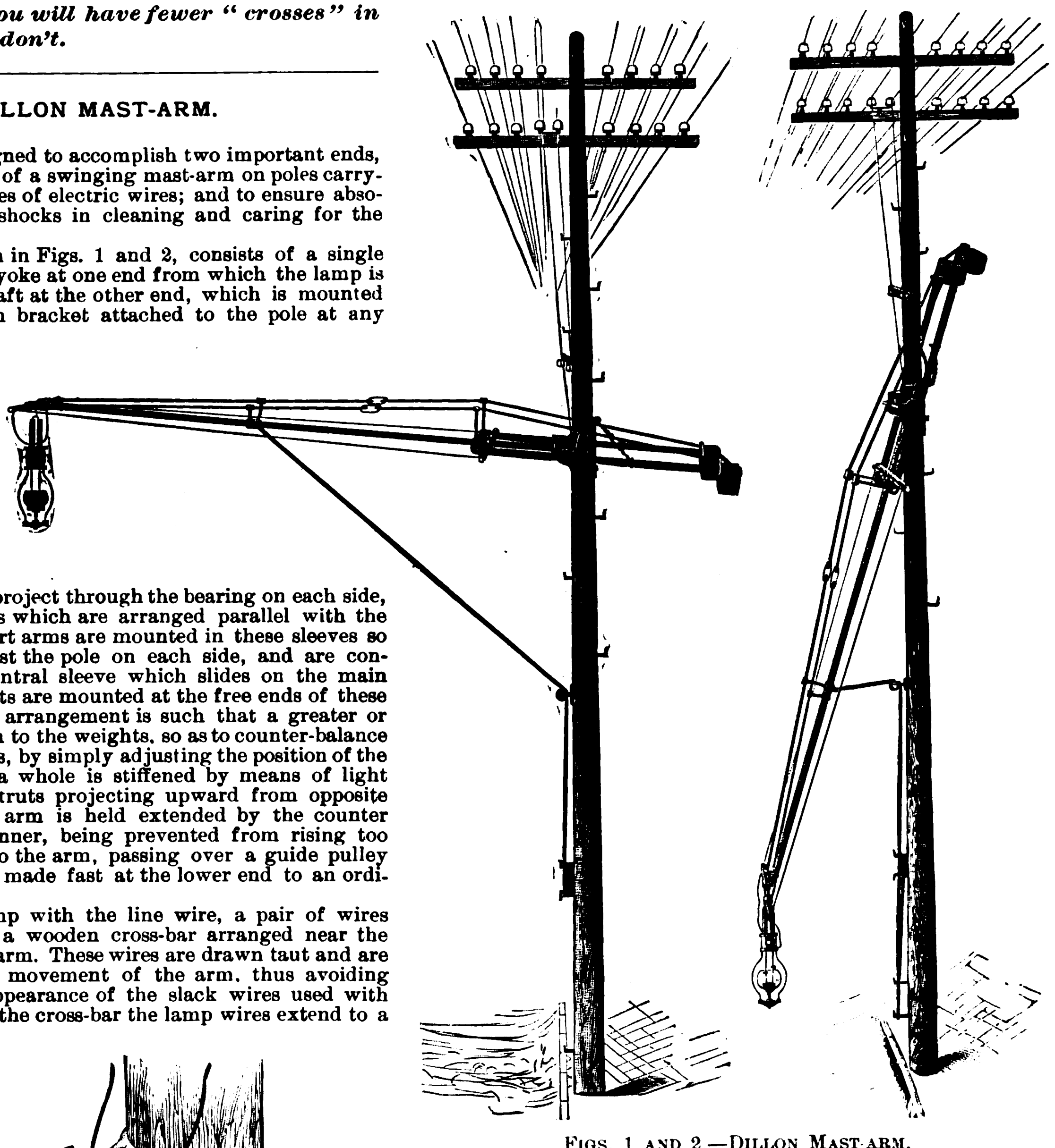
AND MECHANICAL DEPARTMENT.

If you advertise you will have fewer " crosses " in business than if you don't.

THE DILLON MAST-ARM.

This mast-arm is designed to accomplish two important ends, namely, to permit the use of a swinging mast-arm on poles carrying at the top ordinary lines of electric wires; and to ensure absolute safety from electric shocks in cleaning and caring for the lamp.

The arm proper, shown in Figs. 1 and 2, consists of a single piece of tubing, having a yoke at one end from which the lamp is suspended, and a short shaft at the other end, which is mounted in bearings in a cast-iron bracket attached to the pole at any height desired.



Figs. 1 and 2.—Dillon Mast-arm.

The ends of the shaft project through the bearing on each side, and carry a pair of sleeves which are arranged parallel with the main arm. A pair of short arms are mounted in these sleeves so as to extend backward past the pole on each side, and are connected at one end to a central sleeve which slides on the main arm. The counter weights are mounted at the free ends of these short arms and the whole arrangement is such that a greater or less leverage may be given to the weights, so as to counter-balance lamps of different weights, by simply adjusting the position of the short arms. The arm as a whole is stiffened by means of light truss-rods, passing over struts projecting upward from opposite sides of the arm. The arm is held extended by the counter weights in the usual manner, being prevented from rising too high by a rope attached to the arm, passing over a guide pulley attached to the pole, and made fast at the lower end to an ordinary belaying-cleat.

In connecting the lamp with the line wire, a pair of wires extend from the lamp to a wooden cross-bar arranged near the shaft which supports the arm. These wires are drawn taut and are never slackened by the movement of the arm, thus avoiding entirely the unsightly appearance of the slack wires used with other mast-arms. From the cross-bar the lamp wires extend to a pair of binding-posts attached to two copper segments mounted on the supporting shaft, but insulated therefrom.

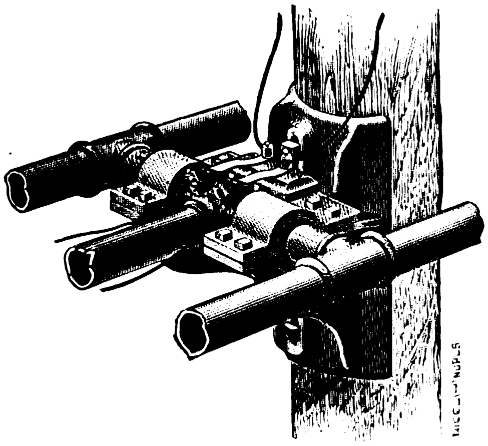


Fig. 3.—Dillon Mast-arm.

The ends of the line-wire terminate in a pair of binding-posts mounted on the bracket which supports the arm, but insulated from it, and these binding-posts are attached to a pair of terminals which rest at their free ends, when the lamp is in position for lighting, on the segments to which the lamp wires are connected, as shown in Fig. 3, so that the current passes from one portion of the line to the first segment, thence through the lamp and off through the other segment to the line again.

The segments to which the lamp wires are connected are of such length that, when the lamp is lowered, they pass out from under the line terminals and become wholly disconnected, the terminals then resting upon a second pair of like segments, also mounted on the shaft, but insulated, and connected by a short bar cast integral therewith, thus forming a short circuit wholly independent of the lamp. By this arrangement, the act of lowering the lamp for the purpose of trimming, separates it from the line circuit, and renders an accident impossible ; and the lamp is automatically put in circuit by the raising of the arm.

This device is manufactured by the Dillon Mast-Arm Co., 126 S. Pennsylvania street, Indianapolis, Ind.

A Striking Picture.—One of the neatest and most novel advertising devices is one recently brought out by the Thomson-Houston Electric Co. It is composed of a very handsome lithograph picture of the Masonic Temple, in which all the windows are cut out, leaving open spaces, which is then placed in a handsome frame supporting several incandescent lamps behind it. When the current is turned on, this gives a most beautiful luminous effect and shows the building as it appears when the lights are running. This company have a picture of the Masonic Temple of Chicago arranged in this manner in their Western office on Michigan avenue, which is excessively attractive in appearance, and which catches the attention of every passer by.

THE JOHNSTON DISCONNECTOR FOR ELECTRIC RAILWAY CIRCUITS.

It is now conceded that the overhead trolley system is the most economical and practical method of propelling street cars; and while many apparent and a few real objections have been made to this system in our large cities, a recent invention of Mr. A. Langstaff Johnston, C. E., of Richmond, Va., removes all of these real and imaginary objections. It is being introduced by the Johnston Safe Automatic Electric Co., of Richmond, Va.

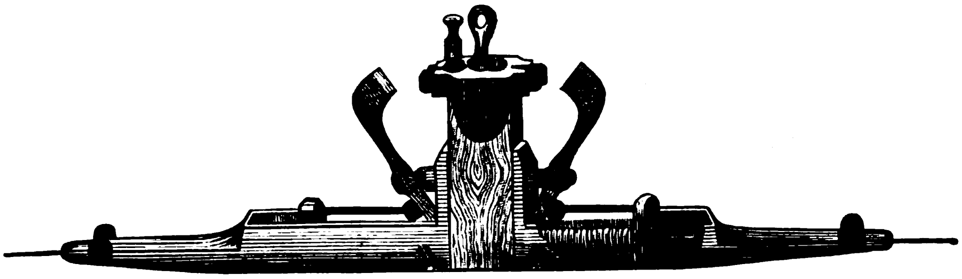
Mr. Johnston, the inventor, is a well-known civil engineer, an associate member of the American Institute of Electrical Engineers, and a member of the American Society of Civil Engineers. He has constructed several of the principal electric railways in this country, and has devoted many years to the study of the subject.

It can be truly said that this invention is an important event in the progressive development of the electrical trolley system, and will popularize the same, as it makes the trolley wire perfectly safe.

This device, when applied to the trolley wire or any wire bearing a current of electricity dangerous to life and property, will, in the event of the rupture of the wire from any cause, thoroughly cut off all electric current, and the wire will fall to the ground uncharged and can be handled with impunity.

It offers special advantage and facility for repairs to any portion of the electric wire line, without interference with the service of any section of the line except that section where repairs are to be made, and without in any manner interfering with the machinery at the power house, a constant flow of electricity being kept up to all other parts of the line by means of the various feed wires.

It is confidently asserted that this device will be of the greatest use to all overhead systems, and a perfect guarantee of safety to the public, as by it the current can be cut off on any section of the electric line without affecting any other portion thereof. It will also prove of great value and convenience in case of fire along the line.



The Johnston Disconnector for Electric Railways.

It is applicable to electric light wires or to any heavily-charged wire; or to wires which cross each other, especially where they are led off into other wires.

The instrument is self acting and perfectly simple. If a wire breaks in a storm or from any cause, the same may be picked up without the slightest fear of receiving a shock, and the wire instantly repaired without interference with travel on any part of the line, except where the break occurs, and there only for a few minutes while the broken wire is being reunited.

The device has been put to a practical test on the Richmond and Manchester electric railway line, where it has been in constant use for some time, and the railway officials say it has proven more than satisfactory and accomplishes all that is claimed for it. With the trolley wire thus made perfectly safe, and the other objections removed by the use of this device, why should not the overhead trolley system be used in all cities?

At least as many as five of the devices per mile are necessary, or wherever a feed-wire is placed, they take the place of the ordinary insulator and thus prove no additional incumbrance to the line.

As will be seen, the device is simplicity itself. The jaws seen in the cut are held together in circuit by the tension of the live wire. When that tension ceases by the breaking of the wire, the jaws are thrown outward by the recoil of the springs disconnecting that section until the restoration of live tension pulls them into circuit again.

A THOMSON-HOUSTON FACTORY FOR CHICAGO.

The following is from the Chicago *Interocean*:

"It is probable that the Thomson-Houston Company will select a site and erect a large factory at Pullman, at least negotiations with that end in view have been under way for some days, with every indication of reaching a favorable conclusion within a short time. Mr. Pullman, Norman B. Ream, President H. A. Pevear, C. A. Coffin, Vice-president, Captain Eugene Griffin, the second vice-president of the Thomson-Houston Company, and B. E. Sunny, the Western manager, visited Pullman December 31, with a view to selecting a location. The grounds were looked over, and the advantages of the different sites that might be selected discussed, but no choice was made at the time. From its extensive interests and its importance, and especially from the amount of capital required and controlled by this company it will be one of the most important acquisitions to Chicago's already large number of industrial institutions. The details have not yet been considered, but a general statement is made by one of the company that about $500,000 will be expended in buildings and a plant and about 500 to 1,000 men will be given employment. The concern, should it established here, will manufacture a full line of electrical goods, including equipment for electric railroads, and will have no connection whatever with the Pullman Company."

LUNCHING WITH THE W. S. HILL CO.

Those of the New York electrical people who were not aware that the W. S. Hill Co., of Boston, had opened a branch office in this city, were apprised of it in a fetching way, Monday, Jan. 4, by a neat invitation signed by the company, requesting the pleasure of their presence at an "At Home" at the office of the company, room 518 Electrical Exchange Building. A handsome lunch was prepared for the consumption of the hungry electricians, and while chicken salad was being washed down with punch, General Manager George H. Poor, Mr. W. S. Hill himself and their New York representative, Mr. E. A. Des Marets, stood ready to explain to those interested points regarding the Hill motor and Hill switches. The Hill motor is remarkable for the comparatively small amount of iron used in its construction and its consequent small weight, besides a very low speed. Electrical offices in lower Broadway, Cortlandt and Liberty streets were generally deserted while the lunch was in progress, and while Mr. Hill had a most excellent opportunity of renewing his old acquaintances in New York, Messrs. Poor and Des Marets improved their time in making new ones. The occasion was also brightened by the presence of ladies.

We believe the W. S. Hill Co. has shown wisdom in opening an office in this city, and we venture to predict for the company the increased and increasing business for 1892 which its specialties merit and its management would seem to guarantee.

RECENT SALES OF BALL ENGINES.

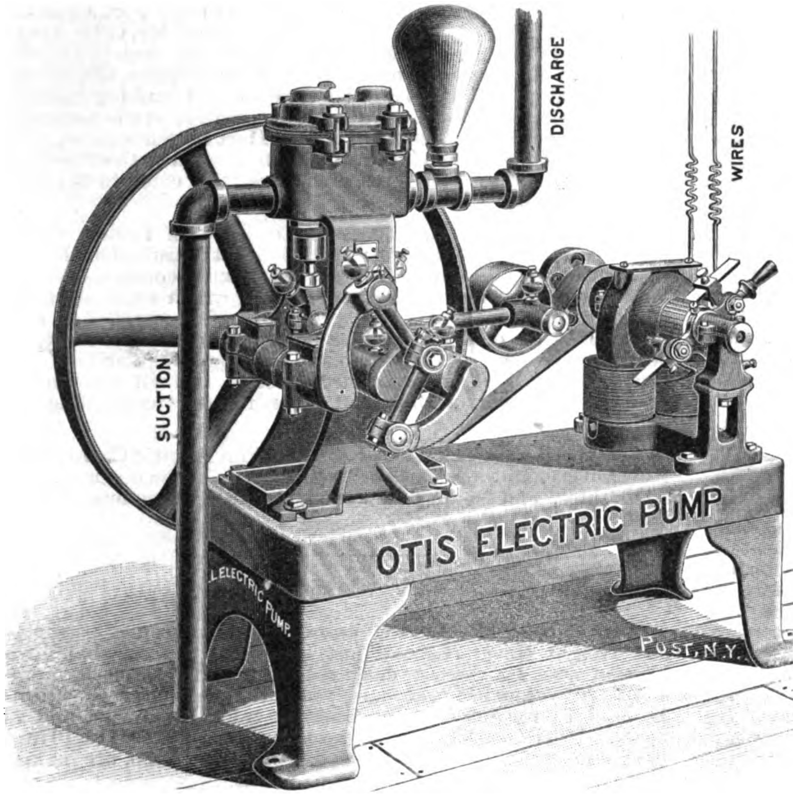
The Ball Engine Co. of Erie, Pa., reports the following sales: Palace Hotel, San Francisco, Cal., one 200 h. p. cross-compound. H. C. Hawks, Boston, Mass., one 35 h. p. single cylinder. The Linderoth Ceramic Co., Chicago, Ill., one 25 h. p. single cylinder. Ohio Baking Co., Cleveland, O., one 80 h. p. single cylinder. Lawrence Gas and Electric Light Co., New Castle, Pa., one 150 h. p. single cylinder. L. H. Goodnow, Fitchburg, Mass., one 35 h. p. single cylinder. Attica Electric Light Co., Attica, N. Y., one 80 h. p. single cylinder and one 50 h. p. The Colonial Club, New York City, two 50 h. p. single cylinder. Citizens' Electric Light Co., Braddock, Pa., one 150 h. p. single cylinder. Youngstown Electric Light Co., Youngstown, O., one 350 h. p. cross-compound. Pittsburgh and Birmingham Traction Co., Pittsburgh, Pa., one 50 h. p. single cylinder. California Electric Light Co., San Francisco, Cal., one 300 h. p. cross-compound. Sauquit Silk Mfg. Co., Scranton, Pa., one 35 h. p. single cylinder. Claremont Electric Light Co., Claremont, N. H., one 80 h. p. single cylinder. Johnstown Electric Light Co., Johnstown, Pa., one 200 h. p. single cylinder. Abington and Rockland Electric Light Co, North Abington, Mass., one 100 h. p. tandem compound. Edison Gen. Elec. Co., New York, two 50 h. p. single cylinder. Wrought Iron Casting Co., South Boston, Mass., one 100 h. p. single cylinder. Cleveland Hardware Co., Cleveland, O., one 50 h. p. single cylinder. Union City Electric Light Co, Union City, Tenn., one 80 h. p. single cylinder. Brush Electric Light Co., Cleveland, O., one 35 h. p. single cylinder. Loraine Electric Light Co., Loraine, O., one 100 h. p. single cylinder. Masonic Building, Richmond, Va., two 60 h. p. single cylinder.

THE OTIS ELECTRIC PUMP.

WITH the marked improvement of the electric motor, and rapid extension of electric power lines, there has grown a popular demand for electric machinery of all kinds. Principal among these is the electric pump. To supply this demand, and to fully meet the exacting requirements of this service, Otis Brothers & Co. have just brought out their latest improvement in this class of machinery, viz., the "Otis Electric Pump."

This pump is constructed to operate upon a novel principle, the water being moved with a continuous and unvarying flow, entering at the suction, and passing through valved pistons, thence out at the discharge. The advantages of this principle of action are many; prominent among which is its entire freedom from the shock, jar, or water-hammer; another is the economy in power naturally resulting from the constant motion of the column of water, as it does not require as much power to keep a body in constant motion as it does to move it with an alternate starting and stopping motion.

Another advantage arising as a natural result of the continuous action is the even distribution of the work at all points of the revolution of the pump, thereby creating a uniform resistance to the action of the electric motor. Besides, the continuous-acting principle, upon which all of these pumps are constructed, avoids the noisy and unsteady operation common in steam pumping machinery in general.



OTIS ELECTRIC PUMP.

For domestic use, and other light services, they are eminently adapted to supersede all of the old troublesome and objectionable devices (with their disagreeable features), such as steam, gas, oil, hot air engines, etc., wherever it is possible to connect with the lines of the electric lighting or power circuit.

The pump is automatic in its action. There is placed at the tank, and in the electric circuit, a switch, which is operated by the action of a float, as it rises and falls with the water; for instance, when the tank has filled to the desired height, the float acts to cause the switch to break the circuit and stop the pump until the water-level is lowered by drawing from the tank; the float then descends and causes the switch to again complete the ircuit and start the pump, to again fill the tank.

These pumps are particularly adapted to furnishing water for omestic use, for office buildings, for irrigation, for watering live ock, for protection in case of fire, operating elevators, as well as many other purposes.

CROCKER-WHEELER DIVIDEND.

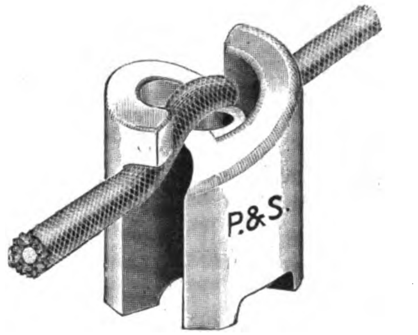
A DIVIDEND of 5 per cent. was paid the stockholders of the ker-Wheeler Motor Company, Nov. 15th. A reserve fund at the same time created, and the balance of the profit was aside for this fund.

ELECTRIC GAS LIGHTING COMPANY.

A VERY complete and well-arranged catalogue is that issued by the Electric Gas Lighting Company, of 195 Devonshire street, Boston. In addition to electric gas lighters of every description, the catalogue comprises a very complete assortment of miscellaneous electrical supplies.

THE NEW PASS & SEYMOUR WIRING INSULATOR.

WE illustrate herewith a very interesting new form of wiring insulator, from Pass & Seymour, the manufacturers of china for electrical purposes, at Syracuse, N. Y. This new insulator does away with the unsightly "tie wire" and does not injure the insulation or make any short kinks in the wire. It will be noticed that the wire passes through the centre of the insulator. This effectually prevents the insulator from turning and throwing slack into the wire, as is the case when the wire is fastened to the side of the insulator. The screw required to fasten it is less than half the length required for other insulators of this class, and when the wire is in position it is hid. Wiring can be done very rapidly with it. The insulators are fastened to the ceiling, the wire is passed under one lug and drawn taut, and then passed under the other lug, the slight bend in the wire holding it taut. The wire is also held a good distance from the ceiling, which prevents the deposit of dust. Such an insulator as this is destined to enjoy a large sale.



PASS & SEYMOUR WIRING INSULATOR.

NEW ENGLAND NOTES.

THE WAINWRIGHT M'F'G CO. OF MASSACHUSETTS report the following sales during the past month: Grand Trunk R'y of Canada, one 600 h. p.; Powers Hotel, Rochester, N. Y., two heaters, 300 h. p.; Barnett & Record, Minneapolis, Minn., two heaters, 350 h. p.; Pomeroy & Middleport Electric Co., Pomeroy, O., one heater, 125 h. p.; Goshen Electric Light Co., Goshen, N. Y., one heater, 125 h. p.; Newport News Electric Light Co., Newport News, Va, one heater, 200 h. p.; Wilmington City R'y Co., Wilmington, Del., one heater, 1,000 h. p.; Fraser & Chalmers, Chicago, Ill., 1 heater, 800 h. p.; American Spool, Bobbin & Shuttle Co., Boston, one heater, 150 h. p.; Derby Street R'y Co., Derby, Conn., one heater, 125 h. p.; Russell & Co., Massillon, O., seven heaters, 885 h. p.; Pittsburgh, Allegheny & Monongahela Traction Co., Pittsburgh, Pa., one heater, 400 h. p.; Buckeye Engine Co., Salem, O., three heaters, 280 h. p.; Stearns M'f'g Co., Erie Pa., one heater, 100 h. p.; Mount Morris Electric Light Co., New York, N. Y., one heater, 200 h. p.; Mahoney, Shenandoah, Girardville & Ashland Street R'y Co., Rappahannoek. Pa., one heater, 200 h. p.; Johnson Wheel Co., Freeport, Ill., one heater, 100 h. p.: Geo. F. Blake M'f'g Co., E. Cambridge, Mass., 3 heaters, 210 h. p.; Montana Electric R'y Co., Helena, Mont., one heater, 250 h. p.; Hughes Steam Pump Co., Cleveland, O., 3 heaters, 180 h. p.; Edward Simon & Bros., Newark, N. J., 1 heater, 100 h. p.; Arbuckle, Ryan & Co., Toledo, O., 3 heaters, 285 h. p.; Phœnix Iron Works Co., Meadville, Pa., 1 heater, 500 h. p., and 35 small heaters amounting to 1,550 h. p. Among the sales of expansion joints the following large orders appear: Pabst Brewing Co., Milwaukee, Wis., 91 joints; Delaware, Lackawanna & Western R'y, Jersey City, N. J., 14 joints; Grant Locomotive Works, Chicago, Ill., 12 joints; Blue Island Engine & Steam Heating Co., Blue Island, Ill., 3 joints; New York Central & H. R. R. R., New York, N. Y., 4 joints; U. S. Government cruiser, "Detroit," 2 joints; U. S. Government cruiser, "Montgomery,"2 joints.

The Electric Gas Lighting Company, of Boston, are out this year again with another interesting catalogue, replete with useful devices for the electrical trade. The frontispiece, this year, is a masterpiece of art, and if one were to deduce any moral therefrom, it would be that the Electric Gas Lighting Company were doing a very "*driving*" business, with a good charioteer at the reins. The catalogue embraces, as usual, all the various forms of gas lighting apparatus, hand and automatic, with their various attachments in the way of switches, cut-outs, keys, etc. Samson, their never-failing champion in the battery line, comes in for his usual share of attention, and is rated as a formidable opponent to all rivals. Electric bells of all kinds, annunciators, including the "Tirrell" gravity drop, next receive attention, the new "Hub" needle indicator, designed for less expensive work, being also well described. All kinds of push buttons and pulls are next set forth, and then follows the Thaxter electric lock, the W. T. door opener, battery supplies, various instruments, tools, alarm clocks, telegraph instruments, etc., electric light supplies and other useful commodities. The Porter electric motor is also given considerable prominence, which it has well merited, having achieved a wide and favorable reputation for itself since its introduction little more than six months ago. Lastly, there is enclosed a sheet giving a full list of discounts, so that the exact price of any article enumerated in the catalogue can be readily and easily deduced.

The Holtzer Cabot Electric Company, of Boston, have recently issued their new catalogue for 1892, embracing a number of novelties introduced by them in the past year. The catalogue commences with their well-known jack-knife switches, single and double pole from 30 to 1,000 amperes; and special mention is made of their switch with movable connections, specially adapted to motor work. This company are also making a specialty of slate switchboards, specially for central station work, and they are present building a very large and complete one for the Brookline Gas & Electric Light Company, of Brookline, Mass. The catalogue illustrates their well-known pressure indicators, automatic controllers, switches, cut-outs, magneto testing machines of special design, sockets, the H. C. ceiling rosette, insulators, insulating joints, and all kinds of fixtures of their own manufacture. The new "Bonnie Breeze" fan motor, brought out during the past year, deserves special mention. There is also a most complete list of tested fuse links and fuse wire, for electric light, power and railway work. Besides these specialties, the catalogue contains a list of numerous articles for which the Holtzer-Cabot Company are agents, and concludes with very useful and comprehensive tables of dimensions, resistances, carrying capacities and weights of commercial wire, carefully compiled by their electrician, Mr. J. Harly Craig. Altogether it is a book well worth preserving.

The Jewell Belting Company, of Hartford, Conn., have just completed a sixty-inch double belt, 185 feet long, for the Newark Rapid Transit Company, of Newark, N. J., which is one of the handsomest belts that they have ever made. This company have had orders for eighteen belts, double and three-ply, within the last month, a large proportion of them for electric light and power work, of which the following is a list: 100 feet of 42 inch double, 190 feet of 32-inch double, 135 feet 60-inch double, 69 feet of 30-inch double, 79 feet of 30-inch double, 115 feet 30-inch double, two belts 103 feet each of 48-inch three ply, 115 feet of 48-inch double, 115 feet of 48-inch double, 40 feet of 48-inch double, 90 feet of 30-inch double, 86 feet 32-inch double, 88 feet 32-inch double, 111 feet of 30-inch double, 57 feet 30-inch double, 123 feet 40-inch three-ply. The Jewell Belting Company are paying special attention to the exacting requirements of belts for dynamos and power generators. They put in the very best of material, and have achieved a well-earned success. Their driving belt department is full of work, both for wide and narrow belts, and they are now better equipped than ever to turn out the best of work in the shortest possible space of time.

The New England Butt Company, of Providence, R. I., report very satisfactory business during the past year, with a marked increase of export trade both to Europe and South America. During the year they have brought out several novelties in braiding and winding machinery, and at present business is quite brisk in all its departments.

The Consolidated Electric Motor Company, of Boston, have secured the control of the Hubbell portable primary battery, the invention of Mr. Charles J. Hubbell, of New York. This small battery derives its power from zinc and carbon, using the ordinary dilute sulphuric acid. The carbon is connected, however, to the bottom of the battery and the zinc is connected at its central point, by which, it is claimed, a much greater current is obtainable. Four of these cells will light up a small lantern, while 8 will run a 10 c. p. lamp continuously for 12 hours, or will run a sewing-machine or fan. The battery possesses several novel features, and is extremely clean and free from smell. The Consolidated Company intend putting them on the market at an early date.

The Eddy Electric Manufacturing Company, of Windsor, Conn., have installed a power plant of of 385 h. p. in the factory of the Encaustic Tiling Company, at Zanesville, Ohio. This plant embraces two generators of 100 h. p. each, driven by Jewell belts from a New York Steam Safety Company, engine, and 12 motors varying from 5 to 35 h. p. distributed in different parts of the factory. They have also installed a 50 h. p. generator and seven motors driving Blackman ventilating fans in the New York State Capitol at Albany, N. Y., and have installed a central power station at Kalamazoo, Mich., consisting of a 60 h. p. generator and 80 h. p. in motors.

The Hart and Hegeman Manufacturing Company, of Hartford, Conn., have recently become incorporated with a paid-up capital of $21,000. Mr. G. W. Hart is president, Mr. G S. Hegeman, vice-president, and Mr. A. H. Pease has been appointed treasurer. Mr. Pease is a new-comer to the company, but is well known in Hartford and vicinity as a bright and pushing business man, and he will form a valuable acquisition to the company. They will continue to manufacture the Hart switches in all sizes up to 100 amperes, and it is gratifying to learn that their business has largely increased and prospered since they came to the East to manufacture.

The American Circular Loom Comhany, of Boston, manufacturers of the well-known "canvas jacket" insulation, have a neat little folder descriptive of their new flexible conduit, designed for the interior wiring of buildings, one of which every electrical engineer ought to possess. This conduit can be supplied on reels in any lengths, does not require any jointing, and owing to its flexibility can be easily fitted to any existing irregularity of surface. It is well worth a careful inspection, and will be found to save a great deal of time and labor in the "conduiting" of buildings.

Mr. George E. Claflin, of the Franklin Electric Company, of Kansas City, Mo., was in the city this week renewing many old friendships, and looking after the interests of his company in the East.

NEW YORK NOTES.

Otis Bros. & Co., the well-known manufacturers of passenger and freight elevators, have just completed a somewhat novel piece of work for the new cable road in this city. The car-house at 129 3d avenue has been equipped with a very large elevator to be used in raising the cars from the tracks to the 1st and 2d floors. The dimensions of the elevator platform are 44 ft. 10 in. x 10 ft. with a capacity of 30,000 lbs. Otis Bros. & Co. are making a specialty of electric elevator installations.

Buffalo, N. Y.—The specifications for the new building of J. N. Adam, of Buffalo, N. Y., call specially for the installation of 90 Ward arc lamps. The electrical equipment will be a very large incandescent plant. When complete this will be the largest and best lighted drygoods house in the city of Buffalo. The Electric Construction and Supply Co. have lately been receiving a large number of Ward lamp orders since the beginning of the year.

The Engineering Equipment Company, of this city, have fected arrangements with the Syracuse Tube Co. whereby t are to control the entire sales in the Atlantic Seaboard State their "tubular" or pipe poles for street railway use. The fa ties of the factories have been increased at least double th former capacity, thus ensuring the prompt filling of all orders.

Mr. H. D. Emerson, of the Creaghead Engineering Co., C cinnati, was in town last week. He reports that the comp has more engineering work on hand than it can attend to.

Prof. J. P. Barrett, chief of the Department of Electricit of the World's Columbian Exposition, spent a few days in the last week. His visit was entirely of a personal nature.

☞ ***Departmental items of Electric Light, Elec. Railways, Electric Power, Telegraph, Teleph New Hotels, New Buildings, Apparatus Wan Miscellaneous, etc., will be found in the adverti pages.***

THE
Electrical Engineer.

Vol. XIII. JANUARY 20, 1892. No. 194.

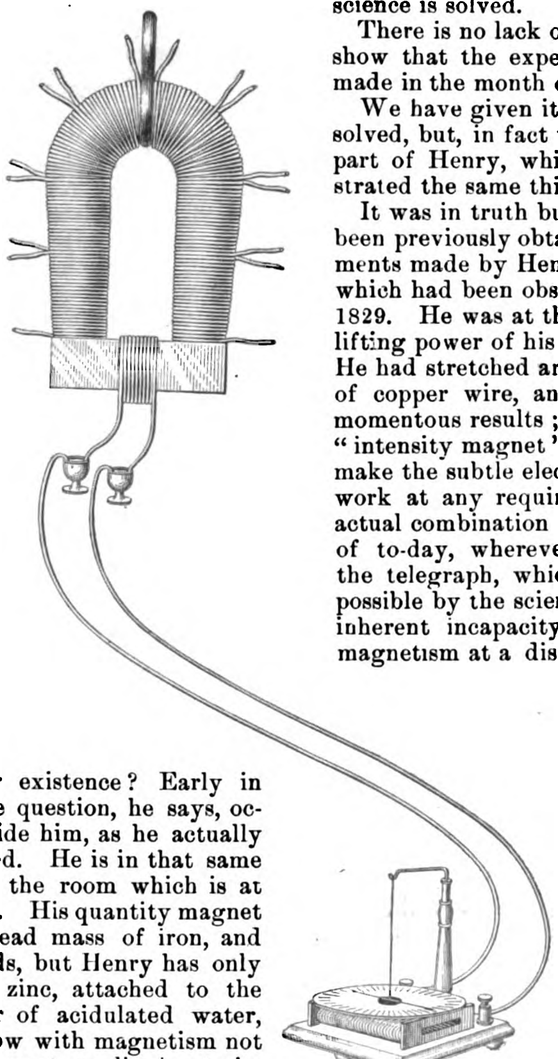
AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—II.

BY

Mary A. Henry

LET us now return to the great discovery which is the subject of our story. The permanent artificial steel magnet, up to this time the sole instrumentality available for interrogating Nature in regard to the point in question, is, as we know, always a magnet. Steel once endowed with magnetism, retains it, at least in some degree, forever, but soft iron has no such capacity. The electromagnet of soft iron remains a magnet only so long as the electric current traverses the wire encircling its core. The electric current is its vital principle; when this ceases its magnetism dies. Springing to intense life in an instant; as quickly losing almost every vestige of energy, these magnets of Henry, not only by their enormous power, by their ready capacity for instant change, were well calculated to betray the great secret which Nature had hitherto so jealously hidden from philosophic eyes.

If electricity can produce magnetism, may not magnetism produce electricity? Surely this was but a natural question for Henry to ask. He had compelled electricity to endow his magnets with their great force; could he do the reverse —compel these, his wonderful children, to produce the electricity to which they owed their existence? Early in the making of the magnets the question, he says, occurred to him. Let us stand beside him, as he actually asks the question and is answered. He is in that same room in the Albany Academy; the room which is at his disposal only during vacation. His quantity magnet stands there in its frame. A dead mass of iron, and copper and wood, it is as it stands, but Henry has only to dip the plates of copper and zinc, attached to the ends of its wires, into a tumbler of acidulated water, and the electric current will endow with magnetism not only the iron horseshoe but the armature clinging to its poles. Around the middle of this armature, Henry winds a thin copper wire, the ends of which he connects with the coil of a galvanometer, forty feet away. Now if this magnet can produce electricity it will, when awakened to life, produce electricity in this wire, and the sensitive galvanometer will betray its presence; *its needle will swerve.* He holds the metal plates suspended over the tumbler; his assistant intently watches the distant needle. What a moment of interest, as he stands there ready to ask the momentous question! He was of an especially reverent nature; he was accustomed at such times to pause a moment and say to himself: "I am about to ask a question of God." The plates are dropped into the tumbler; the electric current begins—the magnet is instinct with living power, and it *does* produce electricity in the wire around its armature, for see—*the needle of the galvanometer swerves.* The question is answered *Magnetism can produce electricity*, but—most important but—only at the instant of the making and breaking of its galvanic circuit. The gnome has at last been caught at work; the great problem of electrical science is solved.



Arrangement of Apparatus in Henry's Crucial Experiment of August, 1830, in which Electricity was First Produced from Magnetism.

There is no lack of evidence, as we shall hereafter see, to show that the experiment we have described was actually made in the month of August, 1830.

We have given it as the one by which the problem was solved, but, in fact this was not the first experiment on the part of Henry, which, when properly interpreted, demonstrated the same thing.

It was in truth but a logical sequence of results which had been previously obtained. It occurred in a series of experiments made by Henry to investigate a curious phenomenon which had been observed by him a year earlier, in August, 1829. He was at that time, in this very room, testing the lifting power of his magnets with different lengths of wire. He had stretched around its bare walls, one-fifth of a mile of copper wire, and had made a discovery fraught with momentous results; the discovery that by connecting his "intensity magnet" with an "intensity battery," he could make the subtle electric force effective to do mechanical work at any required distance. He had in fact made the actual combination which constitutes the electric telegraph of to-day, wherever found and under whatever name; the telegraph, which had been hitherto pronounced impossible by the scientific world, by reason of the seemingly inherent incapacity of the electric current to generate magnetism at a distance. He made his magnet, excited by the intensity battery through that long wire around the room; ring a little bell to announce that the electric telegraph was an accomplished fact; and then the time came, when as usual, he was compelled to give up the room. Many times, during the busy years that followed, Henry rang his little bell, by means of the electric current, for the edification of the Academy students. He was deeply interested in the experiments which led to this important result, but in the course of them a brilliant and unexpected *spark* had flashed under his eyes from a break in the circuit of a long coiled wire, with which he had united the opposite poles of his battery. Nature, like a coy maiden, had lifted her veil for a moment to lure him in a different direction, and so it happened that when vacation came round again in August, 1830, he had taken up the investigation of this new phenomenon, which he called "electrical self-induction in a long helical wire connecting the poles of a galvanic battery." [13]

It was in the prosecution of this new series of researches that Henry obtained, as we have related, the phenomenon of magnetic electricity. From the self-induced currents in his long coiled wire to the production of electricity by his magnet, was only a natural and logical step. Henry, from the first, had considered the two phenomena as manifestations of one and the same principle, and later referred to them as such, in his paper on the subject in Silliman's *Journal*. The world of science has of late years come to the same conclusion. In view of this fact, we may say that the discovery of magneto-electricity was really made by Henry in 1829, when he first obtained sparks from the inductive action of the extra current.

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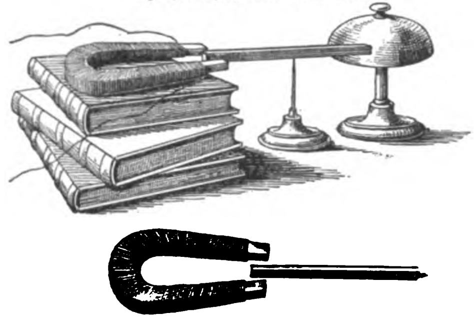


Henry's Demonstration of the Principle of the Electro-Magnetic Telegraph, 1829.

Many other important results were obtained, which cannot be enumerated here, but the inexorable first of September came all too quickly; the academic year of treadmill work; of drilling noisy boys from the rising until the setting of the sun—almost literally, since one of his classes assembled at six in the morning. And so we come down to August, 1831—the August we have dwelt upon so persistently, and very interesting it is now to see what Henry was doing, when Faraday, far away across the sea, is about to enter upon his great work. Spurred to enthusiasm by the brilliant results of the labors of the past year, Henry, to use his own words, is "making preparation for an exhaustive series of experiments upon the identity of electricity and magnetism," and is constructing for the purpose a still larger magnet. But he is not only making this larger magnet, he has constructed a great "reel" wound with a mile of wire. With the magnet we saw him using, and the wire around its armature, he had been able to move a needle forty feet away. What is he doing with this larger magnet and this great reel of a mile of wire? He is making an instrument capable of powerful work. Now look at the picture of a modern "dynamo." What is its essential feature? A reel, wound closely with wire, made to revolve within the influence of a great magnet.

We do not know in what way Henry intended to revolve his reel within the influence of his magnet, but this does not matter. What he is doing in these August days of 1831, is literally *making a dynamo*, in the modern acceptation of the term. Surely, it was not too much to say that Henry was already almost lost to sight in this particular path in which Faraday is only just about to enter. But the first of September came too soon for the completion of his preparations. His room must be given up, as usual, for the ordinary requirements of the Academy.

The great magnet must remain unfinished, and all experiments must cease, not to be resumed until the last two weeks of June, 1832. A glimpse we have of the unfinished magnet standing in Henry's room, in a letter, yellow with age, written by him to Prof. Cleveland, under date Albany, November 6, 1831:

> I have lately had forged a large horseshoe weighing 101 lbs. which I intend fitting up for some contemplated experiments in the identity of electricity and magnetism. It will be more powerful than any heretofore made, being almost double the weight of the Yale College magnet (59½ lbs).

Prof. Silliman hears of the new magnet and writes March 5, 1832, from New Haven to Henry:

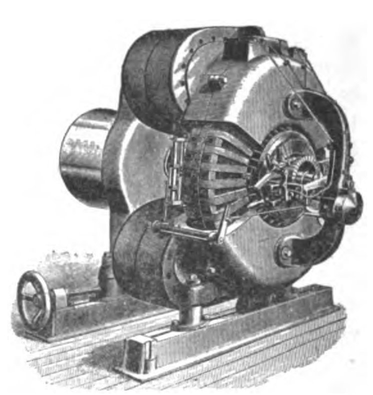
> "I have been told that you have constructed a larger galvanic magnet than those of which notices have been published. I write to inquire if there is anything that you would like to have published in the *American Journal* for April, as to any extension or new application of your discovery. I am informed that you have applied it to the separation of fragments of magnetic iron from the mixtures of other things." [14]

And Henry in his reply of March 28th, 1832, says:

> "In answer to your inquiries as to my further experiments in magnetism, I have little definite to communicate at the present time. I have not entirely abandoned the subject, but have been prevented by circumstances from prosecuting a series of experiments, which were commenced on a very extensive plan. I had partially finished a magnet much larger than any before made, and have constructed a kind of reel on which more than a mile of copper wire was wound. I was obliged to abandon the experiments on account of the room in which my apparatus was erected being wanted for the use of the Academy, and it has not been convenient to me to resume them during the winter."

Other yellow letters tell of the varied occupations of Henry's busy life, which allowed no place for the intensely interesting researches, commenced on so grand a scale and interrupted so opportunely. They were, as we have said, resumed in the latter part of the following June. What was it that set Henry at work at that time? A paragraph in a periodical, announcing that Faraday too had made the great discovery that magnetism could produce electricity. The notice was brief; it showed that electricity in one wire might be made to generate electricity by induction in another wire, and it gave this experiment:

> "In a coil of wire a permanent magnet was inserted, and Faraday found that electricity was produced in the wire when the magnet was inserted in the coil, and when it was withdrawn."



A Modern Dynamo Electric Machine.

Was this the experiment; the one by means of which Faraday made the discovery? We shall see. It should be remembered that this notice conveyed to Henry all the knowledge he had of Faraday's efforts. It impressed upon him the immediate importance of publishing his own results. Although the notice of Faraday's experiment had been published in April, it did not come under Henry's eyes until the following June. He thereupon immediately set to work; repeated the experiments mentioned in the notice, added some others of his own, and hastily prepared a paper for the July number of *Silliman's Journal*, giving—a fact much to be regretted—only a few of the many interesting and important results he had obtained.

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[13] This constitutes the discovery of the extra current made by Henry in 1829, by Faraday in the summer of 1831. M. A. H.

[14] It is a matter of more than casual interest, that this, the earliest industrial application of Henry's electromagnet, should have been the means of directly bringing about the rotary electric motor, as we have it to-day. It was at the Penfield Iron Works, near Crown Point, Lake Champlain, N. Y., and the village at that place still bears the name Port Henry, given to it at that time in honor of the philosopher. In The Electrical Engineer of Jan. 7, 1891, the story of the visit of the Vermont blacksmith, Thomas Davenport, to the Penfield Works, and how he was led to purchase the Henry magnet and to employ it in the construction of an electric motor, has been graphically told by Franklin L. Pope. It is worthy of note, also, that the separation of the constituents of pulverized iron ore by means of magnetism, has within the last year or two attracted great attention, and seems likely to become of vast industrial importance. [Editor.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—II.

BY

Francis B. Crocker and S. S. Wheeler.

Chap. II.—Continued.

The Various Kinds of Circuits on which dynamos and motors are commonly used, and the best type of machine in each case, is as follows:

CONSTANT POTENTIAL.

(*Circuits on which potential or voltage is kept constant, machines, lamps, etc., run in parallel.*)

Circuits intended for—	Potential.	Dynamo should be—	Motor should be—
Incandescent lighting.......	110 volts (2-wire sys.) 220 volts (3-wire sys.)	Plain shunt or compound wound.	Plain shunt wound.
Electric railway. Power circuits....	500 volts.	Plain shunt or compound wound.	Series wound for railway. Shunt wound for stationary.

CONSTANT CURRENT.

(*Circuits on which current or amperes are kept constant, machines, lamps, etc., run in series.*)

Circuits intended for—	Current in Amperes.	Dynamo should be—	Motor should be—
Arc lighting.... Power circuits..	6.8 9.5 or 18	Series wound with current regulator.	Series wound with speed regulator.

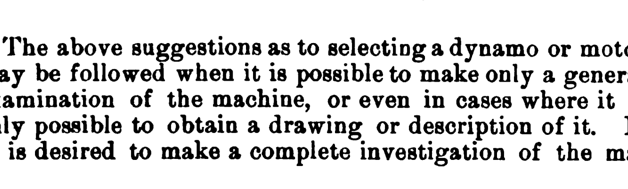


Fig. 1.—Base Frame.

The above suggestions as to selecting a dynamo or motor may be followed when it is possible to make only a general examination of the machine, or even in cases where it is only possible to obtain a drawing or description of it. If it is desired to make a complete investigation of the machine, it is, of course, necessary to make a thorough test and measure exactly its various constants. This can be done as completely as may be required by following the Directions for Testing, which are given in another chapter.

A satisfactory test cannot usually be made, however, until after the machine is set up in place; and, moreover, it is not generally necessary if the machine is obtained from a reputable source.

Chap. III.

DIRECTIONS FOR INSTALLING DYNAMOS AND MOTORS.

Setting up.—The place selected for a dynamo or motor should be dry, clean, cool, away from all pipes if possible, where the machine is in plain sight and is easily accessible and taken care of. Avoid particularly any dusty, wet or hot location. Any place near which grinding, filing, turning or similar work is likely to be done, is very undesirable for a dynamo or motor, as the dust and chips produced are liable to injure the bearings, commutator and insulation of the machine. A firm and level foundation should be provided in any case, and larger machines of 20 h. p. or more should be set on solid stone, brick or timber foundations. It is well, particularly in the case of high-voltage machines, to have them placed upon an insulating base-frame of wood, the pores of which should be filled with paraffine or well varnished to keep out moisture. If a wooden belt-tightening base is used this will answer the purpose, but if iron tracks are used they should be placed on a wooden base-frame. Fig. 1.

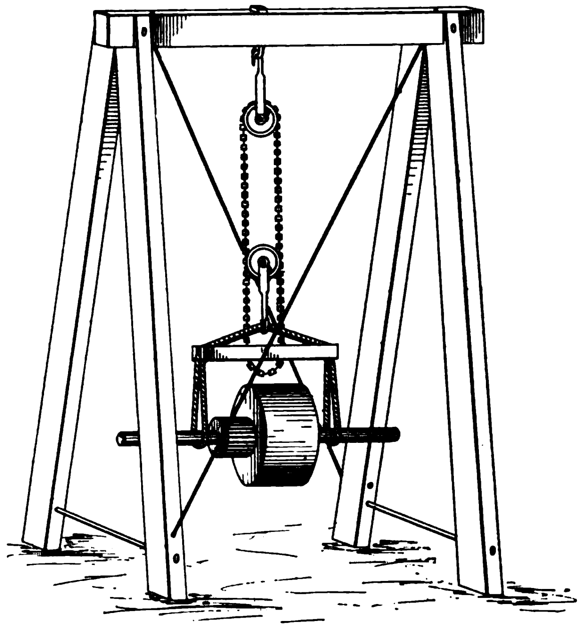


Fig. 2.—Sling for Handling Armature.

In unpacking and putting the machines together the greatest possible care should be used in *avoiding the least injury to any part*, in *scrupulously cleaning each part* and in *putting the parts together in exactly the right way.* This care is particularly important with regard to the shaft, bearings, magnetic joints and electrical connections from which every particle of grit, dust, chips of metal, &c., should be removed. It is very desirable to have machinery put together by a person thoroughly familiar with its construction, and in the absence of such a person no one should attempt it without at least a drawing or photograph of the complete machine as a guide. An exception may be made to this rule if the machine is very simple and the way to put it together is perfectly obvious, but in no event should the installation or management of machinery be left to guess-work. The armature should be handled with the greatest possible care in order to avoid injury to the wires and their insulation, as well as to the commutator and shaft. Handle and support the armature as far as possible by the shaft and avoid any strain on the armature body or commutator. If it is necessary to lay the armature on the ground, interpose a pad of cloth, but it is much better to rest the shaft on two wooden horses or other supports. A convenient form of sling for handling armatures is shown in Fig. 2.

Pulleys.—A dynamo or motor is usually furnished by the maker with a pulley suited to it. In the case of a dynamo, do not use a smaller pulley, and with a motor do not use a larger one without consulting a competent electrical engineer. The size of pulley required on the other machine or counter-shaft to which the given machine is to be connected is found by multiplying the revolutions per minute of the dynamo or motor by the diameter of its pulley expressed in inches and dividing by the revolutions per minute required of the other shaft, which gives diameter of pulley in inches. The proper speed for a dynamo or motor should always be obtained from its manufacturers, and this speed should not be departed from without their approval. A simple rule for determining the sizes and speeds in any belt or gear transmission is that the speed of one pulley or gear wheel multiplied by its diameter must be equal to the speed of the other multiplied by its diameter. An allowance should be made of one or two per cent. loss of speed in the driven pulley owing to the slip of the belt. In fact, the usual result is that the speed actually obtained in practice is less than is expected and this often makes a change of pulleys necessary.

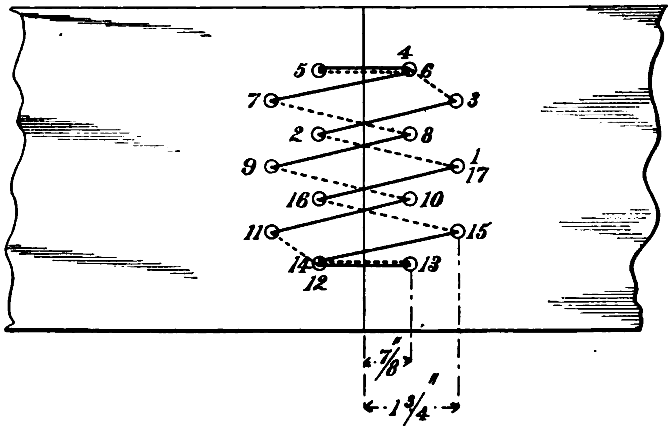


FIG. 3.—METHOD OF LACING A BELT.

Belting.—The kind of belting selected is somewhat a matter of taste but "light double" leather belting is applicable to most cases and is generally satisfactory. The width of belting is usually made about half an inch less than the face of the pulley on the dynamo or motor. The common rule for determining width of belt is that "single" belt will transmit 1 h. p. for each inch in width at a speed of 1,000 feet per minute. If the speed is greater or less, the power is correspondingly increased or decreased.

This is based upon the condition that the belt is in contact with the pulley around half its circumference or 180°. If the arc of contact is less than half a circle the power transmitted is less, as shown in the accompanying table:

Arc of contact of belt.	Fraction of circle.	Power transmitted, *C*.
180°	½	1.00
157½	7/16	.92
135	3/8	.84
112½	5/16	.76
90	¼	.64

The complete formula is, therefore, $\text{H. P.} = \frac{w \times s \times c}{1000}$

that is, the horse-power transmitted by a belt is equal to the width of belt in inches (w) multiplied by the speed of belt in feet per minute (s) and by the figure depending upon the arc of contact (c) and divided by 1000. For example, a belt six inches wide traveling at 1,500 feet per minute and touching three-eighths of the circumference of the pulley will transmit:

$$\frac{6 \times 1500 \times .84}{1000} = \frac{7560}{1000} = 7.56 \text{ h. p.}$$

"Double" belting is expected to transmit twice and "light double" one and one-half times as much power as "single" belting.

The smooth side of a belt should be run against the pulley as it transmits more power and wears better. An endless belt should be used for dynamos and motors since they usually run at high speeds. If an endless belt is not used, the joint should be very carefully laced so as to make it as straight and smooth as possible. In lacing belts, two rows of oval holes should be made with a punch as indicated in the diagram, Fig. 3. The nearest hole should be three-quarters inch from the side, and the first row seven-eighths inch from the end, and the second row 1¾ inch from the end of the belt. In large belts these distances should be a little greater. A regular belt lacing (a strong, pliable strip of leather) should be used, beginning in the middle holes and being careful to have lacing straight on the side next to the pulley, the diagonal parts being on the other side. A six-inch belt should have seven holes on each part; other widths in proportion. Be very careful to measure correctly the length of belt required, as it is very awkward to have it too short or even too long if it be an endless belt. If the machine has a belt tightener, measure for belt when position of tightener makes belt the *shortest* in order to allow for stretch, which is considerable in some belts.

Avoid short or vertical belts as they are much more apt to slip than long or horizontal ones. If it is absolutely necessary to connect pulleys at different levels, make the belt as nearly horizontal as possible. The distance between the centres of two belt-connected pulleys should be at least three times the diameter of the larger pulley, and it may well be four times if the space permits.

Make belt just tight enough to avoid slipping without straining the shaft or bearings. A new belt will not carry as much power as one which has been properly used for a few months.

The dynamo or motor shaft and the shaft to which it is to be belted should be placed exactly parallel and the centres of the two pulleys should be exactly opposite each other in a straight line perpendicular to the shafts. The machine should then be turned slowly by hand to see if the belt tends to run to one side of pulley, in which case the machine should be slightly moved until the belt runs in the middle of the pulleys and does not tend to work to one side.

PRIMARY BATTERY LIGHTING.

THE subject of lighting a small private house with a primary battery is treated in *Cosmos* by M. de Contades in a somewhat novel way, illustrated in detail. The writer describes, apparently from an existing installation, an arrangement for charging secondary batteries from two large sulphate of copper cells with an automatic switch for cutting the secondaries into series. These light 10 lamps, each of .5 ampere, at 50 volts, for seven hours a day. The capacity of the charging cell, working for the other 17 hours, is 1,020 ampere-hours.

BERLINER "ELECTRODES."

BY

John A. Barrett,

Having just received, amongst others, a copy of the patent of Mr. Chas. Cuttriss, No. 464,959, for a telephone transmitter, *sans* "electrodes," my attention is attracted to the scope of his first claim and its relations to certain early forms of transmitters.

The matter seems to be the more worthy of remark, since such a type of instrument has been editorially noticed as a possible circumvention of the Berliner "electrode" patent, and has been otherwise discussed in various superficial aspects.

On page 144 of the 1890 edition of Prescott on the Electric Telephone, in a chapter devoted to Edison's Telephonic inventions of 1877, is introduced a section on "Short-Circuiting Telephones;" and on page 145, Fig. 100, is given an illustration of a transmitter with the following description:

"Still another form of short-circuiting telephone is shown in Fig. 100 (devised Nov. 1, 1887). A spiral spring, 'w,' is wrapped around a cylinder, the diaphragm pressing against the last turn, so that, in vibrating, the convolutions approach or recede from each other. A very slight motion of the diaphragm is sufficient to cause the first few coils to come together; and, in general, the number of coils that thus touch each other is dependent upon the amplitude of the diaphragm's motion. The wire is included in the primary circuit of an induction coil, so that the resistance of the circuit fluctuates as the diaphragm vibrates. This wire has also been used as the primary of the induction coil itself with better results."

The first claim of the present patent is as follows:

"In a telephonic transmitter the combination with a diaphragm of a resilient conducting strip included in the circuit by the connection of its two ends to the diaphragm and stationary terminal support respectively; the said strip being bent or wound upon itself spirally in such a manner that by the vibrations of the diaphragm its convolutions will be closed upon themselves and to a greater or less extent in accordance with the amplitude of such vibrations as set forth."

As to the claims in which the short-circuiting spiral is specified as of carbon material; on page 144 of the same work, Fig. 97, is shown a "short-circuiting" transmitter, in which a metal lever attached to a diaphragm and acting in connection with a strip of carbonized silk, which forms a part of the transmitter circuit, in the course of its vibration cuts out of the circuit parts of the carbon strip.

The definition of those claims, based upon the limitation of the short-circuiting spiral to carbon as a material, would probably raise some nice legal points as to the degree of invention involved in the combination of the material of one instrument and the mechanical arrangement of the other; the material in question performing radically the same electrical functions in both forms.

Aside from questions such as these, as to the scope and validity of the Cuttriss patent, questions which may, perhaps, be regarded as mainly personal to those interested in this particular patent, there is a broader field of inquiry opened in this connection, in which lie the roots of the whole telephone transmitter problem.

What are Electrodes in a Microphone Transmitter? And what unquestionable distinction with respect to the radical function of the Variable Resistance may be set up between the electrodes of the Berliner and the absolute continuity of the short circuiting or Cuttriss type?

I shall not attempt to lead to any undebatable conclusion with respect to these questions; but I propose to show that the apparent distinction of types may possibly be superficial merely, and that there is room for an argument which might bring back the Cuttriss departure into the fold as a true "Electrode" Transmitter within the reach of the Berliner patent.

With regard to the term "electrode," as employed in the Berliner patent, it is always dangerous to use a technical term descriptively outside the scope of its conventional significance; not so dangerous, perhaps, to the one who first so employs it, as to those who come after him.

In the present instance the term electrode in its technical sense conveys decisively the idea of the separation, or at least the separability of the two terminals of a metallic electrical circuit. Strictly, there are usually understood to be two electrodes, which are the ends respectively of the metallic portion of an electric circuit, and their separability in service is a functional condition of their existence as electrodes.

A provision for establishing an uninterrupted mutual contact between the two terminal portions—or bodies, if they are so represented—for the purpose of enabling them to accomplish an object, which in a separated or separable condition they could not accomplish, terminates for the time and purpose their function as electrodes.

Electrodes in constant contact with each other are technically an anomaly.

But a special appropriation of the term has been made in Berliner's patent to a matter not within its strict technical acceptance, and a sufficiently intelligible definition for the purposes of the patent is given in the specifications of the patent itself, so that in all discussion of Berliner's patent and its relation to other patents, the term electrodes must be divested of its technical sense, and employed simply to designate those parts of the transmitter, to which Berliner has applied it in his specifications. It is emphatically important not to allow the term in itself to convey any significance of the essential form, arrangement, or offices, of those parts, but to be merely a symbol of reference to the drawings and specifications. The radical function and the principle of action of the parts marked electrodes must be determined by an examination of the entire patent, in connection with certain accepted propositions with regard to the subject at large.

Broadly speaking the parts—those specially designated as electrodes—are certain metallic elements, between the several portions of which a constant contact is maintained. This contact is specifically stated to be constant; that is, continuous and never to be interrupted by the normal service of the transmitter, and means are provided for preserving this contact unbroken within the limits of such sonorous vibrations as the instrument is adapted to.

It is upon this very point of the absolute continuity of the electric circuit through the transmitter system that the courts have shut out the Reis telephone from being held to be a genuine speech transmitter. Berliner states directly that any interruption of the circuit produces independent sounds foreign to the normal operation of the instrument. This is the distinction upon which Reis has been counted out, and it is upon this ground that Berliner expects to be supported for the full scope of his claims.

This, then, may be stated as an accepted theory of action of the speech transmitter, namely, that the circuit must be maintained permanently closed during normal use; a theory which has been generally confirmed by experts, adopted by the courts and accepted by the public.

It now becomes important to inquire in what way the parts designed for that purpose—the parts named electrodes by Berliner, and under that term described and illustrated and claimed by him—may be understood to perform their functions.

These functions are twofold, to wit, to cause the current occupying the circuit to fluctuate by the infinitesimal progressions constituting the undulatory curve, and at the same time always to maintain an unbroken continuity of the circuit.

Berliner says that when the pressure at the points of contact is varied it produces a variation of resistance and a corresponding variation in the current. The essential feature is the Point of Contact, which must offer a resistance to the current, but must not be entirely broken.

It is necessary to discuss this Point of Contact somewhat carefully, as herein is probably the essence of the whole question.

I do not suppose that a mathematical point can have any electrical conductivity, so that it is necessary to hold that the point of contact in its full meaning is more accurately an area of contact.

Now, an area of absolute contact between two portions of conductor has *per se* infinite conductivity and reciprocally no resistance, since it is a plane or series of planes, and, as a path to the current, has no length. In this respect it is identical with a hypothetical area of cross-section of a homogeneous conductor.

But if the clean surfaces of two metallic bodies are brought lightly together so as to establish an electrically-conducting circuit between them, a considerable resistance, properly enough called *contact resistance*, is observable. It is probable that however lightly the surfaces may touch each other, a plurality of planes of absolute electrical contact are established of limited and indeterminate area. It should be carefully noted, nevertheless, that the contact resistance should evidently be referred to the length and cross-section of the paths along which the electrical current must converge through the conducting bodies towards the planes of contact. An increase of pressure between the two bodies by increasing the total area of the planes of contact makes the sum of the converging paths shorter and broader until a point may readily be reached when the contact resistance becomes inappreciable.

This conception of contact resistance and the method of its variability is probably useful and accurate in determining the principle of action of all microphonic transmitters from Reis to the latest improved "Hunning." It is obviously a principle comprehended within the Berliner claims; not to give it the greater distinction of being the sole fundamental principle to which those claims must be limited.

The second essential requirement of the variable resistance medium of the speech transmitter is that it should not interrupt the electrical circuit during normal service. In order to fulfil this requirement, if a variable contact is employed between the surfaces of two or more physically separable and individual conducting bodies, those individual bodies must be so attached to each other in fixed and absolute continuity of contact, that the normal operation of the instrument will not at at any time completely separate them. They must be so joined together electrically as to present a unified conducting organism for the purposes of the instrument. It is no longer consistent with their operative function of maintaining a continuous conductivity, to regard them as separable and individual pieces or bodies. Physically they may be separable into a plurality of parts; but functionally in the transmitter they are essentially inseparable and constitute a continuous electrical conductor as absolutely as if they were riveted or amalgamated or welded together.

It is reasonable to argue, therefore, that the so-called electrodes of Berliner are not, in fact, the surfaces respectively of a plurality of individual-conducting bodies acting against each other, but that the term is more broadly applicable to different portions of the surface of a continuous conductor brought into relations of mutual contact; both the continuity of the conductor and the variability of surface contact being stated as essential by Berliner.

It is possible to confirm such a position by other concurrent arguments, but as the purpose and limit of the present article were to raise a question and not to reach a judicial conclusion, it is unnecessary to diverge upon them.

In accordance with this theory of action, then, it may be held that Berliner's claims would surround any transmitter in which the continuity of the conductor is maintained, while the electrical resistance is increased through an elongation and constriction of the conducting path by the separation of short-circuiting areas of contact between mutually respective surfaces of portions of the resistance organism, and decreased by the reverse action.

It is consequently not to be confidently asserted that the spiral-spring continuous-conductor short-circuiting transmitter is a distinct type not infringing the Berliner claims.

THE EXPRESSION FOR THE WORK DONE BY MOTORS.

BY

Albert L. Arnet

In Mr. Thorburn Reid's formulæ for motors in The Electrical Engineer of Dec. 23, 1891, occurs this formula for the work done by the motor, a two-pole series machine:

$$W = C e \qquad (4)$$

where W is the work available at the motor pulley; C the current strength, and e the counter E. M. F.

Now supposing the motor to be supplied with current from a source of constant E. M. F., E, the energy imparted to the motor is given by

$$W^1 = C E;$$

so that we have for the efficiency of the motor at a given speed the expression

$$\text{Efficiency} = \frac{C e}{C E} = \frac{e}{E};$$

or the efficiency is the ratio of the counter E. M. F. to the E. M. F. of the mains. This agrees with Prof. S. P. Thompson, Dynamo Electric Machinery, p. 521. It does not agree however with Kapp, Electrical Transmission of Energy, p. 186. For the work available at motor pulley Kapp gives the following expression:

$$W = (C - c)\, e$$

where C = the current strength,
c = the current required to run the motor at best speed without load,
e = counter E. M. F.

On the basis of this Kapp gives some tabulated results of experiments with a certain motor whose most economical speed was 1,010 revolutions. The resistance of armature and line was .2 ohm. To run the motor at 1,010 revolutions, unloaded, required 4 amperes of current. The E. M. F. of the mains is 100 volts.

One table is as follows:

No.	Speed.	e	C	Com. Effic.
1	1010	91	45	82.8
2	1065	96	20	76.7
3	944	85	75	80.0

The especial point of interest to me has been to reconcile these efficiencies with Joule's law. As yet I have not succeeded, and I offer this in the hope that some one will kindly explain the matter. In case (3) of the table above, the energy lost as heat $C^2 R = .2 \times 75^2 = 1125$ watts; while in (2) $C^2 R = .2 \times 20^2 = 80$ watts. Now Kapp tells us that in (3) the motor is more efficient than in (2), notwithstanding the fact that the amount of energy lost as heat in (3) is 14 times greater than in (2).

If I interpret correctly the formula of Mr. Reid, the efficiencies of the motor for the three cases cited should be respectively 91 per cent., 96 per cent., and 85 per cent. I am disposed to think that these values are nearer the truth than those in the table quoted from Kapp.

THE NEW TELEPHONE EXCHANGE FOR ATLANTA, GA.

THE telephone exchange of the Southern Bell Telephone Co. of this city, at Atlanta, Ga., now has nearly 1,300 subscribers on the Law system, and the business is in such excellent condition, with promise of increase, that the company has decided upon building a new exchange headquarters. In fact the work has already begun, ground having been broken for a fine edifice that is to be completed by the fall of 1892. Our illustration of the new exchange is made from an admirable engraving published by the *Atlanta Constitution* in a recent historical sketch of the local development of the telephone industry. The building will stand at the corner of Pryor and Mitchell streets, Atlanta, and will cost at least $70,000 exclusive of the land. It will be built of fine Georgia granite. No part of it will be rented, but it will be devoted wholly to the purposes of the company. The operating-room, or exchange proper, will be on the third floor, and the whole of the switchboard apparatus, etc., will be entirely new, provision being made for three or four thousand subscribers. The second floor will be occupied by Mr. John D. Easterlin, the district superintendent at Atlanta for a large section of country, while Manager W. T. Gentry will have the ground floor for his suite of offices. The basement will be devoted to material and supplies. The absence of a wire cupola on the roof, and of wire supports, is noticeable. The reason of their disappearance is that Mr. D. I. Carson, the secretary and general superintendent of the Southern Co., has made arrangements for placing all the wires underground, an ordinance to that effect having passed the city council. It is intimated that cement-lined pipe may be used for the conduits. A large sum of money is to be spent on this work. Mr. James A. Wotton, the electrician of the company, will have charge of a fine laboratory and repair shops, and of the electrical work in general. Altogether the new departure in Atlanta is one of importance, as the exchange is the first of its magnitude and completeness in the South. It is expected that the central office will be moved next December, when Atlanta will have a service worthy any city in the Union.

NEW ATLANTA TELEPHONE EXCHANGE.

A COMBINED ACCUMULATOR AND GAS BATTERY.

BY

F. A. LaRoche

THE escaping bubbles of gases from a storage cell during the operation of charging will attract the attention of the most casual observer, and no doubt cause speculation as to the amount of waste energy of which the elimination of these gases is significant. A long association with the construction and practical working of electrical accumulators, with their ever-escaping gases constantly in view, prompted a desire to utilize this waste. The ideal electrical accumulator would embrace among its features the return of all the energy expended in its charging. After much careful thought and many preliminary experiments with this end in view, the results to follow were noted. It is needless to wade through each successive step leading up to the final experiment, since all previous efforts culminate in the last. Therefore it is sufficient to commence with a discription of the completed cell.

This cell was a curiosity; the container was made of a section of wrought iron steam pipe 4 inches in diameter and six inches in length, with a cap screwed upon each end. The internal arrangement of the cell required much care and careful calculating—the plan of this cell was a combination of the Wollaston gas battery with the usual accumulator. Therefore it was necessary to have two separate compartments, one within the other, and the large one twice the capacity of the other. The smaller of the two compartments contained the + plate while the — plate was placed in the larger. The reason for this arrangement is as follows: Water, when a current of electricity is passed through it, is electrolyzed and its constituent gases eliminated upon the metal conductors at the point of contact with the water. Now water (H_2O) is composed of 2 volumes of hydrogen and 1 volume of oxygen. The oxygen is liberated at the positive pole; therefore this pole is placed in the smaller compartment. This precaution is necessary because it is essential to have equal pressure within the cell to maintain the acidulated water of the battery at a common level. The sides of the cell were protected from action of the battery liquid by an impervious coating. The small compartment was made by securing an inverted porous cup to the lid of the cell; this cup was partly coated with pitch, so that the portion above the level of the liquid was made impervious, while that portion opening beneath the liquid retained its porosity.

The battery plates were made of two small sheets of lead, each two inches square; these plates had been previously filled with litharge and carefully formed; their electrical capacity was accurately ascertained in the open before being closed in the cell. When everything was made ready the cell was closed and hermetically sealed. A pressure gauge was next fitted to the cell as a precautionary measure; also an escape cock. By this arrangement the escaping gases were kept separate and confined under pressure, oxygen within the porous cup, hydrogen outside in the larger compartment.

Wollaston proved that oxygen and hydrogen when separated by a partition, always enter into combination, and produce a current of electricity, provided the gases are in contact with one liquid conductor and that the gases and liquid are traversed by metallic conductors connecting only outside of the battery. This is the principle underlying the present experiment. It was hoped that by keeping the evolved gases under pressure, they would, to a large extent, be condensed and held either in solution or suspension within the battery fluid and thus be brought into more extensive contact with the metallic conductors. The result, it was reasoned, would be an increase of ampere capacity only, for the chemical affinity between oxygen and hydrogen is such, that, under the most favorable conditions, not more than two volts E. M. F. can be expected from their reaction. The combination of the gas battery supplied but the same chemical agents. The small battery plates used, gave on the test, two volts full, but no more. These facts went to confirm the belief that the only possible gain would be in quantity and that the voltage would remain unchanged.

Finally all arrangements were completed and with anxious expectancy the terminals were screwed fast in the binding-posts, and the current switched on.

A current of five amperes was used for charging the cell. Presently the index on the pressure gauge began to register, steadily the hand went around the dial until, after three hours had passed, the current was cut off and the gauge indicated 300 lbs. to the square inch.

The test of the cell was performed as follows: The terminals were connected with a small motor with an amperemeter in circuit; the voltmeter used in the previous test was connected across the terminals.

The most remarkable feature in the whole occurrence was the fact that the voltmeter persisted in registering a fraction over three volts. Contrary to all reasoning the unexpected had happened; nevertheless, the fact remained, because a calibrated instrument still registered with certainty the three volts and a trifle more. Several hypotheses have arisen to account for this, but without making any effort to explain the phenomenon, we will simply state the fact and go on with the remainder of the test as follows:

Time.	Volts.	Amperes.	Watts.
1 hour.	3	3.5	10.5
2 hours.	$2\frac{7}{10}$	3.2	8.64
2½ hours.	2	3.	6.

After 2½ hours' discharge, equivalent to 25.14 watts, the E. M. F. fell rapidly and the battery was then recharged for a second test. This varied a little but not materially from the figures given in the first test. In a later trial the pressure gauge ceased to register and the charging was continued until suddenly a flaw in the metal was developed, whereupon the contents of the cell were spurted across the room. With this disaster ended a series of remarkably interesting experiments.

THE VAN VLECK DISCONNECTIVE TRIPLE EXPANSION NON-CONDENSING ENGINE FOR CENTRAL STATIONS.

Note has already been made in these columns that the Edison Illuminating Company of this city in extending its present plants, and in the installation of its new ones particularly, had contemplated the adoption of large units embodying generators driven direct by multiple-expansion steam engines of the latest type. Where the loads on the station permit of the employment of large units the installation of dynamos direct connected permits of the highest economy, a fact which has so often been pointed out as to need no further comment at this time.

As a first step in this progressive movement, the company have within the last few weeks installed in their Twenty-sixth street station a 1,000 h. p. triple-expansion engine, designed by Mr. John Van Vleck, which, we believe, will attract more than ordinary attention in electrical engineering circles. Our engraving, Fig. 1, shows the engine as it now appears in the station; while Figs. 2 and 3 give respectively a detailed view of the side and end elevations.

This engine is probably the first large triple engine intended for direct connection to multipolar dynamos in any American central station, and it is interesting, both on this account and because it possesses several advantages that are of vital importance in a generating plant, in which economy and reliability are the most important factors.

The engine is of the three-crank inverted cylinder type, and will generate from 600 to 1,000 h. p. according to steam pressure, and only occupies about one-tenth of a square foot of floor space per horse power. The three cranks employed produce a very steady rotation of shaft which is very important in a direct-connected electrical generator.

The engine is designed to run non-condensing, which may surprise some American engineers who seem to associate a triple engine with a condenser, and who do not seem to agree with certain European engineers who claim that steam pressure above 160 or 180 pounds makes condensing undesirable, and under some conditions, even an expense. At present, however, this engine is being operated under a pressure of 125 pounds, and gives excellent results even when partially loaded, although it should be remembered that the high-load factor necessary to supply a district in New York with light and power will permit of running engines of this size up to their full capacity, and that they need rarely run on partial load.

The engine is furthermore interesting in that it is probably the first triple-expansion land engine ever set up, at least in this country, which possesses the feature that any of its three cylinders can be disconnected and thrown out of gear without preventing the engine from running; in fact, it can be run as a triple or compound, or even a single-cylinder engine, at will. The engine is, therefore, not one "unit" but three separate "units" combined, any one of which may be disconnected in case of trouble with any one of them. As far as we know, this principle has only been applied by one or two English engine builders in the construction of their tandem quadruple engines.

The general construction of the Van Vleck engine is such that it can be applied to a triple or quadruple engine of any size from 500 h. p. upwards, while this cannot be said of that class of engines having centrifugal automatic governors on their main shafts which cannot very well, with slow speed, control several large-size valves, which, to be tight, must take power to operate them. In this case the valves are "positive driven" by means of the Joy valve gear controlled by a hydraulic governor. In this way even the greatest amount of valve friction cannot in the least affect the speed of the engine.

All the regulating and valve gear is placed on the front of the engine, where it can all be seen and operated from

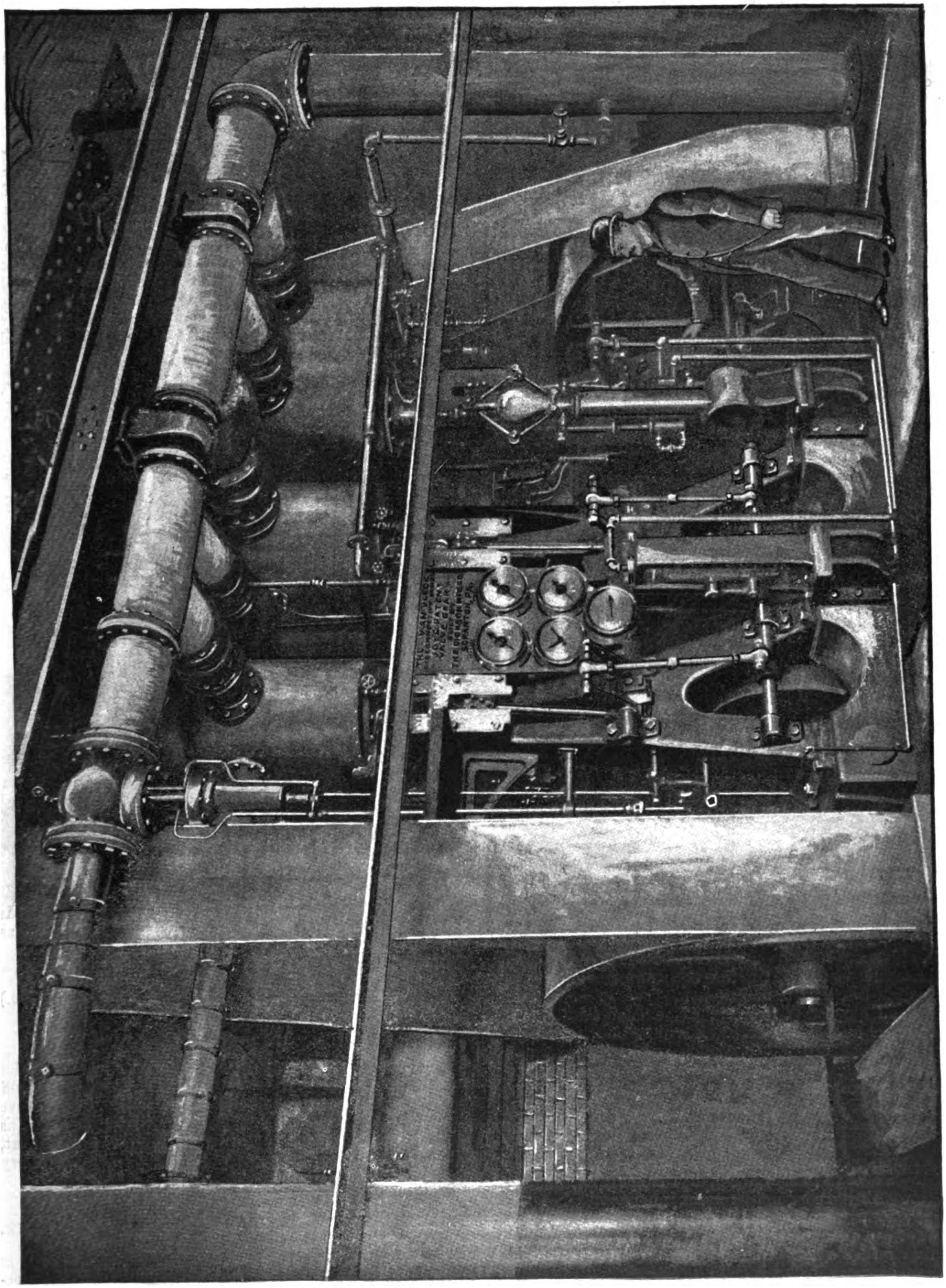


FIG. 1.—VAN VLECK DISCONNECTIVE TRIPLE EXPANSION NON-CONDENSING ENGINE FOR CENTRAL STATIONS.

the centre aisle through the station. The operating engineer need, therefore, but rarely go behind his engine or between the columns as in the case of the ordinary arrangement of triple engine with steam chests between the cylinders.

The point of cut-off is automatically controlled on all three cylinders, a feature, probably not possessed by any other triple engine. The exact point of cut-off in each cylinder is indicated on a dial attached to the "slipper guides," so that the engineer can always see just where his point of cut-off is. By means of a novel adjustment the point of cut-off on each cylinder can easily be altered while the engine is running, while the speed can also be changed without shutting down.

The general construction of the engine is thoroughly modern, and is on a par with the excellent work now being done on English and American war vessels. The engine has water-jacketed main bearings and slide surfaces, and its piston heads and piston covers are of the simple "coned" pattern and are made of cast steel.

The engine is the result of much study on the part of Mr. Van Vleck, who believes that he has developed in his new combination the best possible and most reliable land engine for this class of work. Much valuable assistance has been given him by such engineers as Messrs. S. F. Prest and David Joy, of London, while the designing of details has been mostly in the hands of Mr. W. J. Sargent, of Scranton, Pa.

The engine was built by the Dickson Mfg. Co., of Scranton, whose success in constructing this engine is greatly to their credit. We understand that this type of engine, in its triple and quadruple form, is to be energetically exploited for central station work. It will be built for steam pressures of from 200 to 300 pounds, and in its quadruple arrangement will, it is claimed, give a far greater economy than has heretofore been the attained practice.

In connection with this advanced type of engine it is gratifying to note that important steps have also been taken in the way of improving the ordinary American methods of steam piping and fittings. The entire system of piping furnishing steam to this engine is of the most substantial character. All the cast and wrought iron portions of the piping are much heavier than is usual, while the flexible copper parts of the pipe are banded with iron bands placed every five inches apart. This is probably the very first American copper pipe treated in this way, and we think that if such advanced practices as we have seen in this case could only become more common, then steam pressures of 200 pounds and over would be met with in every first-class stationary steam plant, where, with multiple-expansion engines, the high efficiencies now obtained at sea would be realized by the land engineer.

THE THEORY OF THE PERRET MAGNETIC FIELD.

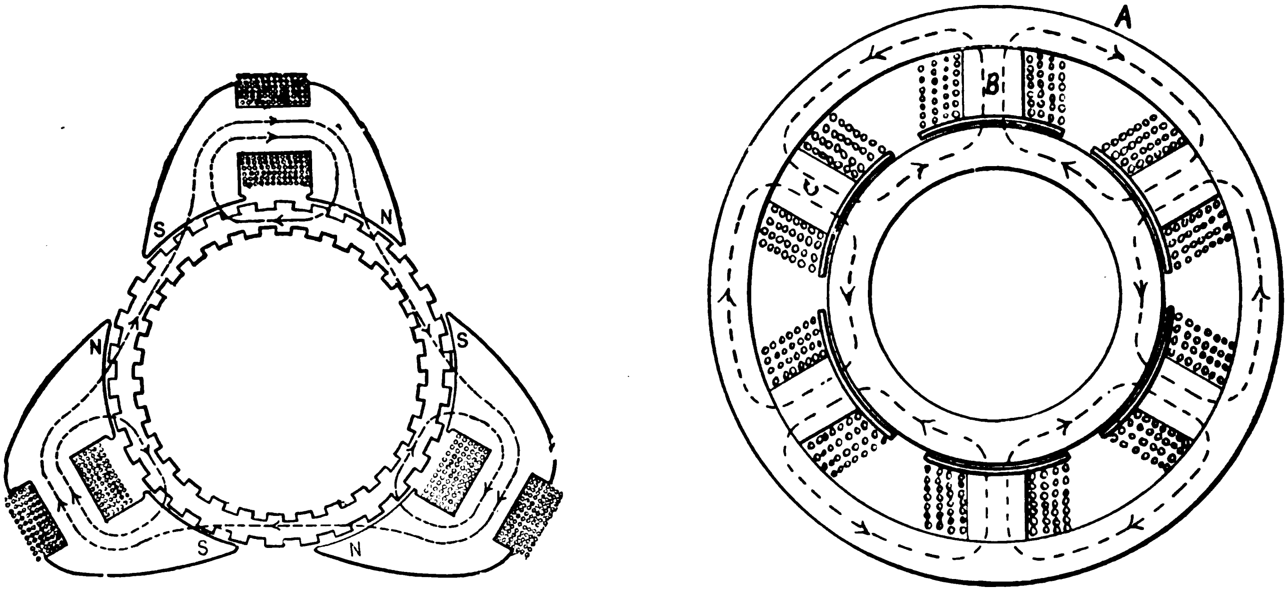
BY

H. R. Wellman

I CANNOT but think that there is a grave error in Mr. Perret's theory as to the advantage, in multipolar construction, of the magnetism entering and leaving the armature at several points in succession.

Taking the "Perret" type shown in Fig. 1, and assuming that the total flux *does* enter and leave the armature at six points successively, as shown by the continuous line of arrows, then, the three fields being in series, the whole number of lines is clearly the magnetic carrying capacity of each. Calling this M, the number of volts E generated per conductor for a given speed S, is

$$E = S\frac{M \times 10^{-8}}{60} \times 6 = S M 10^{-9} \qquad (1.)$$



FIGS. 1 AND 2.—THEORY OF THE PERRET MAGNETIC FIELD.

Taking the typical six-pole machine, Fig. 2, the fields being two in series, the magnetic capacity is 3 M, and as this is cut twice, we have,

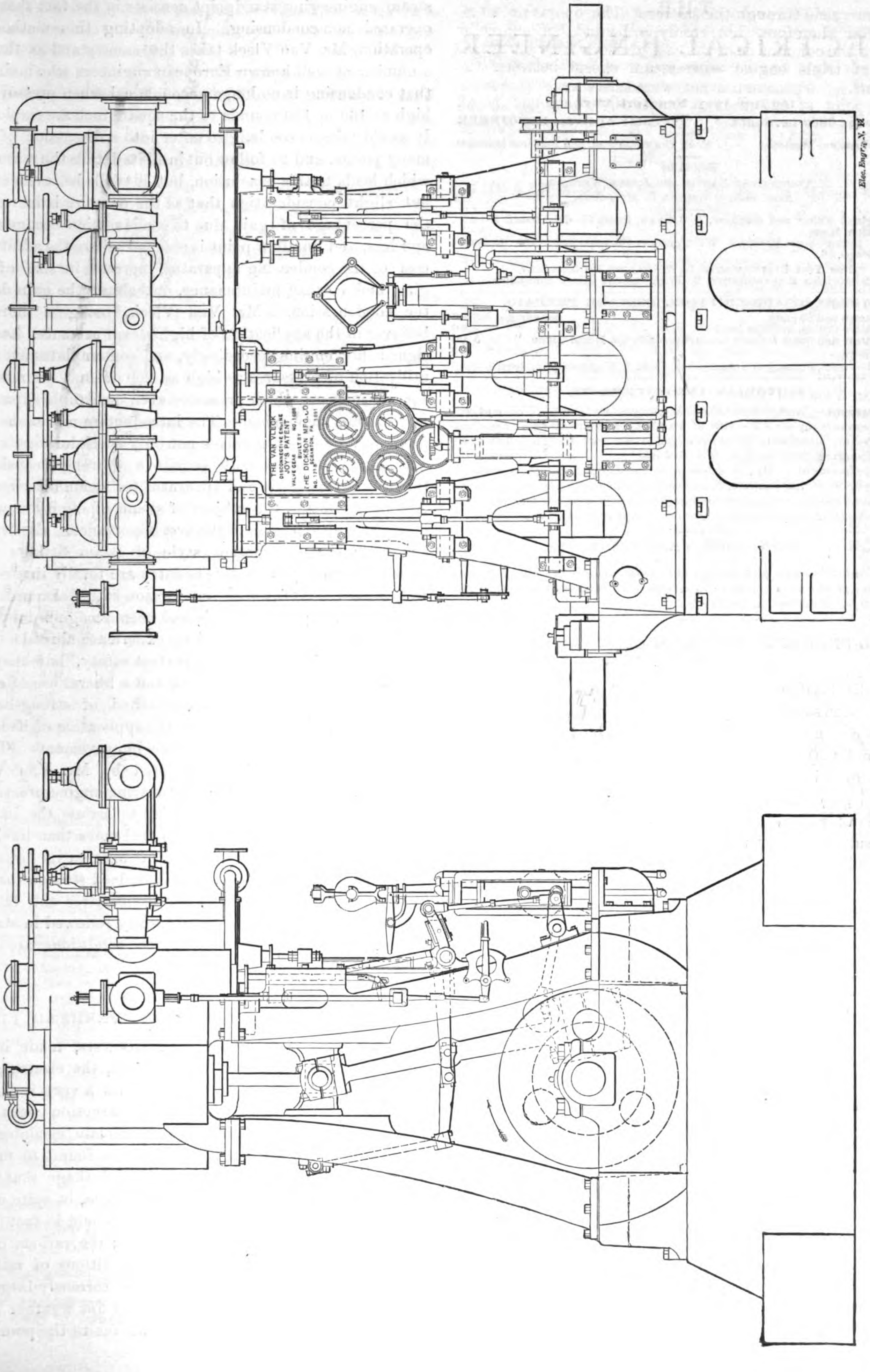
$$E_1 = S\frac{3\ M \times 10^{-8}}{60} \times 2 = S\ M\ 10^{-9}, \qquad (2.)$$

which is identical with (1.)

Furthermore, if the poles are equidistant around the armature, surely not more than one-half of the lines would pass from the positive pole of one pair to the negative pole of the next, the remainder taking the other path, as shown by the short lines of arrows, which would prevent, to that extent, the machine operating upon the theory propounded.

ELECTRICAL UTILIZATION OF WATER POWER.

A PRIZE is offered by the Société des Eaux et de la Dranse, in Switzerland, for the best system for the electrical utilization of a fall of water. Particulars of the competition may be had from the Secretary of the Société des Ingénieurs Civils, of Paris.



Elec. Engr'g. N.Y.

FIG. 2.—VAN VLECK DISCONNECTIVE TRIPLE EXPANSION NON-CONDENSING ENGINE FOR CENTRAL STATIONS.

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VOL. XIII. NEW YORK, JANUARY 20, 1892. No. 194.

The end of the new philosophy is to subordinate the blind forces of nature to the uses of man; to mitigate the ills and multiply the joys of life.—Edward N. Dickerson.

HIGH-PRESSURE STEAM IN CENTRAL STATION WORK.

ELECTRICAL engineering has from the beginning been so intimately connected with steam engineering that it has in a certain sense come to be looked upon as part and parcel of it. Many of the failures which have been scored in electrical work have been due to lack of knowledge of the principles of steam engineering; while, on the other hand, the many successes scored have been the result, largely, of the application of correct steam engineering in connection with electrical work. Although the cardinal principles of central station practice are fairly well defined, the controversy which has been going on in our columns for some time past, as to the most economical size of power units, shows that on several details a considerable divergence of opinion may still be met with. While "Carleton" and Mr. William Lee Church agreed substantially on the size of this unit which they fixed at 500 h. p., they were not entirely agreed on the relative merits of the condensing and non-condensing engine. At the other extreme we find Mr. J. T. Henthorn, whose experience confirms him in the belief that the slow-speed Corliss compound engine, acting through counter-shafting, is capable of effecting the highest economy in central station work. To these varying practices may still be added another, a most striking example of which is that now described by us and which is illustrated in the Van Vleck disconnective triple-expansion non-condensing engine. Aside from the fact that this engine is probably the first of the triple-expansion type to go into an American central station, and intended ultimately for direct connection to multipolar machines, its most striking feature from the steam engineering standpoint consists in the fact that it is operated non-condensing. In adopting this method of operation, Mr. Van Vleck takes the same stand as that of a number of well-known European engineers who maintain that condensing is no longer economical when pressures as high as 160 or 180 pounds to the square inch are employed. It would take us too long to enter into a discussion of the many points, and to follow out in all its details the reasoning which leads to this conclusion, but it will be evident on but slight consideration that as the pressure is increased, the percentage of gain due to condensation becomes less and less, and finally a point is reached where the additional cost of the condensing apparatus, increase in size of engine and cost of maintenance, outbalance the gain due to the condensation. Mr. Van Vleck, being a thorough believer in the application of high-steam pressure, has designed his engine accordingly, and contemplates even the utilization of pressures as high as 200 or 300 pounds per square inch, at which pressures even quadruple expansion will become economical. The introduction of such high pressures, however, involves not only special design of engine parts, but necessarily entails a thorough considerations of the methods and apparatus for steam distribution. Among the latter, the subject of steam piping is one which much be considered as of the first importance. Experience has shown that the present style of steam fittings most generally employed in this country are totally inadequate and, in fact, unfit for use in connection with steam pressures as high as 200 pounds. This had been recognized by Mr. Van Vleck and is confirmed by experience abroad. Such pressures can be carried with perfect safety, but they require the most substantial work and a liberal use of metal to withstand the strain. The method of strengthening copper pipe, for instance, by the application of bands at short intervals is one among these improvements. Taken as a whole, the work inaugurated by Mr. Van Vleck adapting, as it were, the best marine engine practice to stationary land engines will not fail to arouse the interest of central station managers and will more than likely influence not a few in the adoption of high steam pressures for central station work. It is indeed strange that the employment of these pressures in locomotives and latterly in marine practice should be so tardily followed in stationary engine practice where all the conditions are most favorable to their successful use.

PORCELAIN INSULATORS FOR OVERHEAD LINES

THE appeal to porcelain manufacturers, made in our columns last week, by Mr. F. W. Jones, the electrician of the Postal Telegraph-Cable Co., touches a very important part of telegraph and telephone construction work. As Mr. Jones pointed out, although porcelain insulators are given the preference in Europe and are found to present three or four times the resistance to leakage that glass does, our companies continue to use glass, in spite of the great loss of efficiency in service. It would in fact be interesting to know just what becomes of the various classes of telegraph circuits under heavy conditions of rain and damp. Our own impression is that a seriously large proportion of them is "shut down" until fine weather comes around again, and that this is chiefly due to the poor character of the insulation at the poles. We doubt whether in this respect there is any material gain over the efficiency of twenty-five years ago.

Mr. Jones by his appeal to the porcelain manufacturers of America has assumed that with them rests the remedy, and that if they will give us porcelain insulators cheap enough and good enough, all will be well. On these points we have now been favored by Mr. C. H. L. Smith, of the Union Porcelain Works, of Brooklyn, with copies of a very interesting correspondence between himself and Mr. Jones, and the data thus submitted is important. Mr. Smith remarks in a letter to us, with great truth and pertinence, that the question of the most perfect insulation obtainable will before long be well recognized by those who use electric plants of any kind as one of the prime factors in reducing operating expenses, but he seems to fear that for the present the short-sighted policy will prevail of looking only at the first cost of the equipment. In one of his letters to Mr. Jones, he says but too truly: "The managers of European lines look at other points than the first cost of their insulators. Unfortunately in our country, in too many cases, quality is sacrificed to price, and the first, and sometimes the only, element that cuts any figure in transactions is, 'What is the price?' The glass telegraph insulator being much less costly than the porcelain, our electricians as a rule have very little option in the matter. They are compelled to work with such tools and equipment as the management provide for them." In other words, the tariff plays little part in the matter, and there is no need to consider importation, if the companies interested will only buy what they can already get. Has any determination been arrived at, we would ask, as to the exact point at which the loss of efficiency and business on our telegraph lines, from poor insulation, would be less or greater than the added outlay required for high-class insulators?

As to the porcelain itself, Mr. Smith is worth quoting:

> "The insulating properties of porcelain depend upon its quality. You are no doubt aware that there are many goods manufactured that have somewhat the general appearance of porcelain but in reality are not *true* porcelain. Such inferior goods do not make a good insulator but are quite deceptive in their appearance. True hard porcelain such as we manufacture is identical with the class of insulators used in Germany and France, and is a superior insulator to that used in England.
>
> "In regard to the glaze of true hard porcelain, it does not better the insulator one particle. The body of the true porcelain is as perfect an insulator as the glaze. The only objection to omitting the glaze is that the surface of the body becomes more quickly and readily soiled. We have thoroughly and carefully investigated this whole matter, and the only point that interferes with the general use of a porcelain telegraph insulator, which is an item only in first cost."

This last sentence is plainspoken, although it deserves to be borne in mind that the question of renewals comes in. We believe that about 6 per cent. of the Western Union insulators are renewed yearly. But here again, however, there might be an economy in a smaller percentage of renewals.

In another letter to Mr. Jones, objection is made by Mr. Smith that the former's requirements do not go quite far enough, and that

> "A high-grade porcelain insulator should be composed of simple earths only, both in body and glaze, and of the same material. No lead or other metallic oxides must enter the composition of either glaze or body. It must be absolutely vitreous and perfectly homogeneous. The body and glaze must be fused together at the highest porcelain heat, which is over 4,000 degrees Fah. It must be resistant to all influences of heat, cold, dampness, acid or alkali fluids or gases."

With the need so well recognized and with the ability to supply it so well manifested, there should be little delay on the part of porcelain manufacturers in this country in finding a new market in the telegraph field.

THE CENTRAL STATION AS A DISTRIBUTER OF ENERGY.

THE intelligent central station manager has long recognized that to obtain the greatest measure of success in his work, he must be prepared to furnish electrical energy in any form and practically for every purpose required. This has given rise to not a few composite stations in which side by side we find the low and the high tension, the direct and the alternating current employed for lighting and power purposes, and latterly for heating by the current. But there is still another method by which a central station may distribute energy in the form of heat. Probably more than nine-tenths of the present existing stations are so situated that the operation of condensing engines is impracticable, so that the steam as it leaves the cylinder is exhausted directly into the atmosphere. The latent heat contained in the steam thus thrown away forms by far the largest part of the energy originally imparted to it from the coal under the boilers, and if the central station manager can in the same way utilize this waste product, he is to that extent availing himself of his resources and as a result increasing his revenue. The utilization of this otherwise waste steam has recently been advocated in connection with electric central stations and appears to us to be one of the most promising fields open to electric light and power companies, provided, of course, the conditions, among which is the situation of the station, are such as to permit of the thing being done. As illustrating the facility with which such distribution can be carried out, we give in another column a description of the system designed for this purpose by the American District Steam Co., which embodies the experience obtained in the practice of a long period of time. As the system involves a distribution under a pressure of but a few pounds to the square inch, the question of danger and leakage involved in high steam pressure distribution does not here come into play, so that it remains merely a question of calculation as to the successful application of this system.

Another Object-Lesson in Car Heating.

ON the evening of January 8, the cars on a street railway at Scranton, Pa., were stalled. In expectancy of a long delay in reaching the car barn, five men, employees of the road, entered an empty car, stretched themselves on the seats, and slept. The heating device used upon the car kept them warm; and it also very nearly killed them. The fumes from the stove did the deadly work. Now it seems to us worth while to remark that the Burton Electric Company has worked incessantly the past season to correct the evil condition of things occasioned by the heating devices now used upon the street car lines in this country. It has placed its absolutely clean, safe and efficient electrical heaters upon 100 lines the past year.

THE VARLEY LOOP TEST.

BY

J. A. Jones

MR. FRANK L. POPE's 1891 edition of the "The Electric Telegraph," so admirably adapted to the wants of the electricians, managers and operators to whom it is addressed, in a few particulars has some shortcomings that detract from its value to the students less advanced. For the benefit of those interested I will call attention to "Varley's Loop Test," on page 203. The bridge, Fig. 1, is there shown with the $A\,B$ and $C\,B$ arms equal in resistance and the rule is given, on page 204, to subtract (2) (the resistance in $E\,A$ to balance) from (1) (the total resistance of loop) and divide the remainder by 2, which gives the resistance between the instruments and the fault.

This rule is correct only for measurements made with equal $A\,B$ and $C\,B$ arms. As there are a great number of submarine and underground wires in use at the present time it becomes necessary to employ methods of measurement that will give a closer approximation to the true position of the fault than by the foregoing method where it may not be arrived at closer than one unit of resistance, which, in the case of an underground cable, means about 400 feet of wire. It is obvious that such a test has but small value.

It is usual to make "Fault" tests with the arms of the bridge multipled. If an ordinary bridge is used, the range of which does not exceed 10,000 ohms then the arms $C\,B$ and $A\,B$, Fig. 2, are made 10, and 1,000, respectively; provided the loop does not exceed 100 ohms when the fault is near the point E. Having first ascertained the resistance of the loop, and of the wires between $C\,D$ and $A\,D$ when possible by test 346a on page 201, the Varley test is then made thus:

Assuming the figures in the diagram Fig. 2, between C and D, and A and D, to additively represent the resistances of the looped conductors it will be found that $R^3 = 7{,}475$ ohms, and R^1 the resistance from E to the fault = 25 ohms, — which is given by the following formula, where $a = 10$ ohms; $b = 1{,}000$ ohms; the loop $L = 100$ ohms; $R^3 = 7{,}475$ ohms; $R^1 = 25$ ohms.

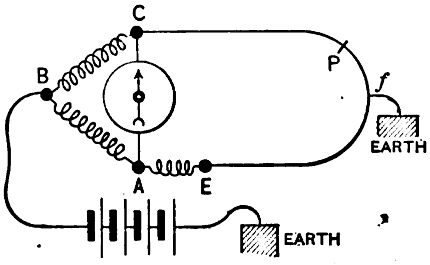


FIG. 1.

$$\frac{L\,b - a\,R^3}{a + b} = E \text{ to } x,$$

$$\textit{Example:}\ \frac{(100 \times 1000) - (7475 \times 10)}{10 + 1000} = 25 \text{ ohms.}$$

Should greater range of measurement be required a special bridge is necessary with higher resistance in the arm R^3, and the test made at the ends farthest from the fault. The above formula holds good with the arms $A\,B$ and $C\,B$ multiplied 10 to 100 or in any other ratio. With 10 to 100 the loop may be 1,000 ohms but the fault cannot be so closely located, as it may not be possible to bring the spot of light to zero by adjustment of the resistance R^3. In such a case Kempe's formula will be found valuable.

EXAMPLE: a and b being 10 and 1,000 ohms, respectively, $R^3 = 156$ ohms, gave a left-hand deflection of 15 degrees; $R^3 = 157$ ohms, gave a right-hand deflection of 20 degrees; then the correct resistance x will be given by this formula:

$$x = \frac{10}{1{,}000}\left(156 + \frac{15}{15 + 20}\right) = 1.5643 \text{ ohms, nearly.}$$

It is to be remembered that the earth to which the battery is attached must be the outside metallic sheath of the cable, or connected to an earth plate in which there is no difference of potential between it and the cable conductors. Should the cable conductors have low insulation (in addition to the fault) there will be a natural resultant fault which will tend to throw the true position of the fault to one side of the place located by the tests. In this case Kempe furnishes a correction, as follows: The difference in ohms between the apparent position of fault and the true position

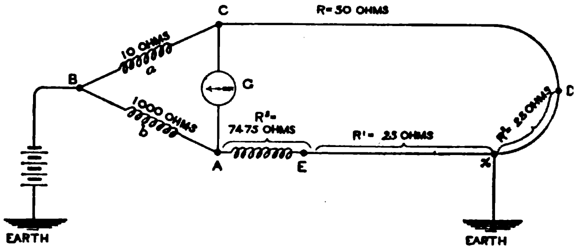


FIG. 2.

$$= \frac{I}{P - I}\left(R^1 - i\right) \text{ ohms.}$$

Where P = the absolute insulation resistance in ohms before the fault occurred;
I = the absolute insulation resistance in ohms with fault at time of test;
R^1 = apparent distance in ohms of fault by loop test;
i = apparent distance in ohms of natural resultant fault obtained before fault occurred.

Accuracy demands care, coupled with a correct bridge, and a good dead beat reflecting galvanometer with corrections properly applied for variations of temperature in the apparatus and wires.

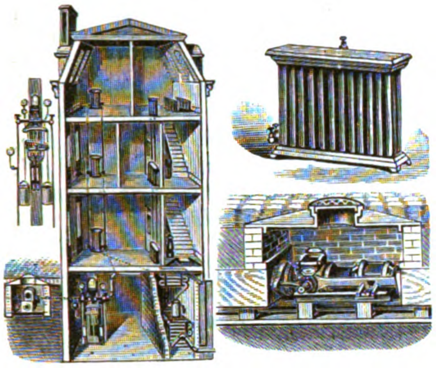
ELECTRICAL EXPOSITION IN MOSCOW.

THE Moscow Section of the "Imperial Russian Technical Society" will open an Electrical Exposition in that city on April 14th to the 26th, 1892.

The programme published by the board of management mentions eight groups, as follows: 1, electric light, transmission of power; 2, telegraphy and telephony; 3, electro-technology (electro-metallurgy, electrolysis, electro-plating, etc.); electricity as applied for railway use, military and marine purposes, medicine, and domestic economy, etc.; 4, electric piles, condensers, static apparatus, thermo-electric batteries, dynamos, motors, etc.; 5, motive power, boilers, motors used for electro-technical purposes; 6, scientific apparatus, measuring and precision instruments; 7, novelties; 8, literature, plans, designs, diagrams, etc., pertaining to electricity.

Exhibits will be admitted free of duty, provided they are returned within one month of the closing of the Exposition, or if given to the Imperial Russian Technical Society towards the formation of a museum or electro-technical laboratory. In the event of a sale, however, the duty will be exacted. Prizes, in the shape of gold, silver and bronze medals, etc., are to be awarded.

DISTRIBUTING EXHAUST STEAM FROM CENTRAL STATIONS.



ELECTRICITY as a commercial product for the lighting of cities and villages, or to furnish power for running stationary motors or street cars, or for other industrial uses, has necessitated the construction of many large steam plants for its development. Now it is well known that only about 10 per cent. of the heat in steam passing through the engine is converted into mechanical energy, and that nine-tenths remains available for the heating of houses, stores and public buildings, provided this exhaust steam can be distributed where it is wanted without too much expense, or too great loss by radiation in transmission. If this can be done, then the exhaust steam of central stations, which is usually thrown away, can be made an important source of revenue. As revenue is the incentive to the establishment of all industrial enterprises, it follows that the prudent manager will not long neglect to utilize the resources at his command. Sometimes the location of a station may not be favorable to the profitable distribution of its exhaust steam, but in most cases a short line of underground pipe laid in the streets, will reach districts of residences or business blocks, from which services can be taken off to buildings on either side. Many steam systems proper are now in operation so that this plan of steam distribution can no longer be called an experiment.

Some twelve or thirteen years ago Mr. Birdsill Holly, the inventor of direct pumping for water-works systems, conceived the idea of heating cities and villages, and supplying power therein with steam carried underground in protected iron pipes. There were serious obstacles to overcome, one of which was the buckling and breaking of the iron pipes on account of their expansion and contraction, caused by changes of temperature. This was accomplished at first by the device which he termed a "junction service box," placed at intervals in the mains. This was a steam-tight box into which sections of pipe could expand, the other end of the section being stationary. This box also served as a fixed point from which to take off service pipes to the buildings along the streets. The objections to this plan were that these packed joints required occasional repacking, and necessitated the construction of manholes in the streets in order to gain access to them. This device is shown in the vignette at the head of this article.

Later the device now in use in the "Holly system" was invented, known as the "Variator," a sectional view of which is shown in Fig. 1. This embodies a corrugated copper diaphragm, with cast-iron backing plates for strength; the yielding and reflex action of which provides for varying lengths in the sections of pipe. No stuffing-box is required in this, and the device is protected from

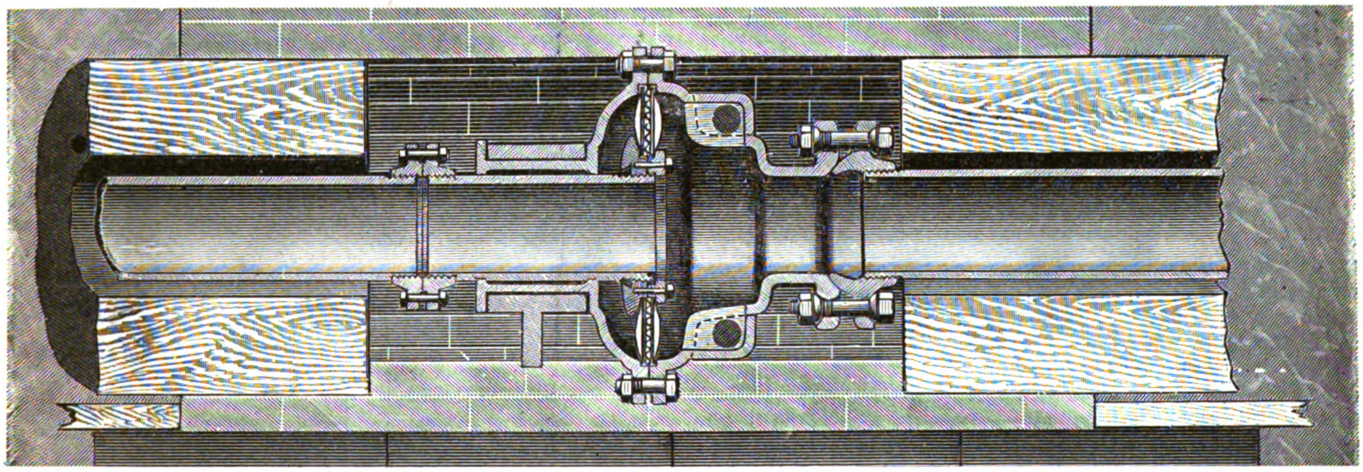


FIG. 1.—SERVICE VARIATOR, SECTIONAL VIEW.

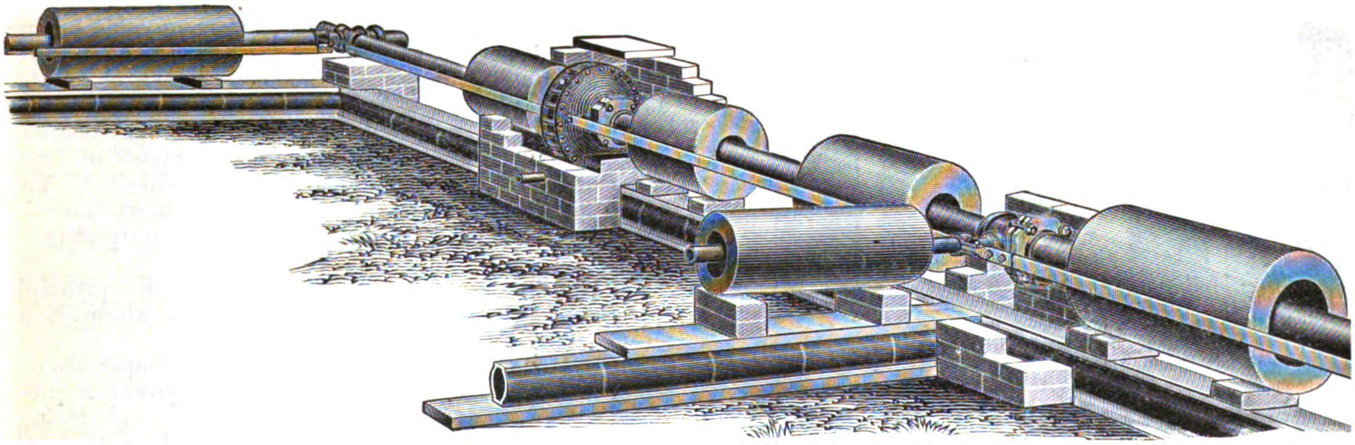


FIG. 2.—SECTIONAL VIEW OF A LINE OF STEAM MAINS, SHOWING IRON PIPE, WOOD LOG COVERING, ANCHORAGE, VARIATORS AND STREET ANGLES.

contact with the earth and covered the same as the pipe itself, no manholes being required.

Another point to consider was the prevention of undue radiation of heat from the pipes, which would be the case if they were laid in contact with the moist earth. Experiment showed that this could be accomplished by the use of pine logs, bored for the purpose with four-inch shell, the outer surface being coated with asphaltum. These were tenoned together and the iron pipe, which is first covered with asbestos, is inserted therein. Under this pipe is laid a line of tile, with proper outlet to convey away any surplus water in the surrounding earth. Service pipes to the buildings are laid in a like manner. A sectional view showing the method of construction is shown in Fig. 2.

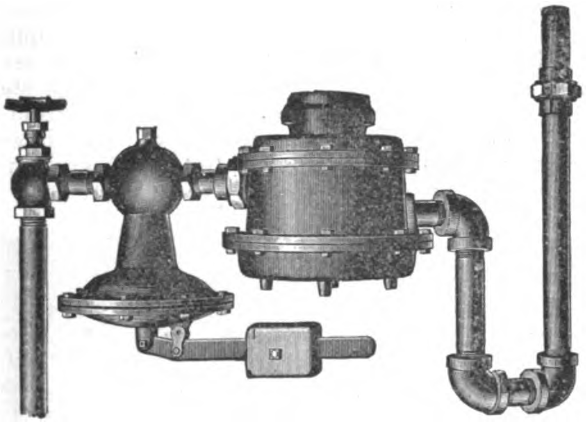


FIG. 3.—HOLLY'S REDUCING VALVE AND STEAM METER.

The steam is first conveyed into the basement of the building, passes through the "regulator," which reduces the steam pressure to a low and uniform pressure, and then through the steam meter, which records the amount of steam used by each consumer. The meter and regulator are shown in Fig. 3. The Holly system differs from the ordinary house system, in that it does not return the water of condensation. This water goes from the radiators to a trap shown in Fig. 4, and then to a cooling coil in the basement, where all the heat is abstracted and passes through a register in the floor above; the water then passes to the sewer; or, being chemically pure, may be used for any purpose desired.

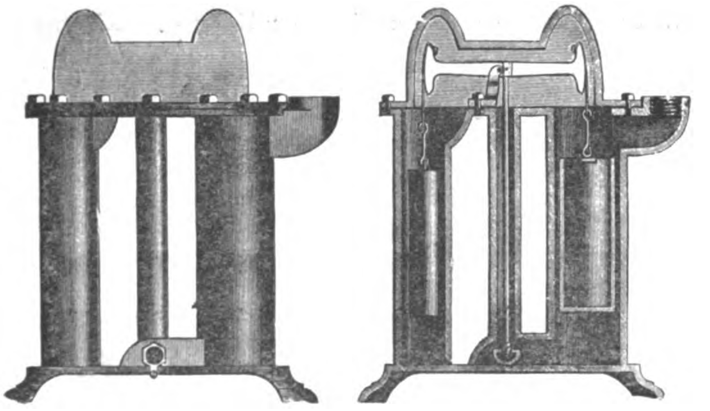


FIG. 4.—HOLLY'S STEAM TRAP.

It is calculated that 100 h. p. of steam will heat one million cubic feet of space; and a fair commercial rate to be charged for heating with steam in most localities is $4 per thousand cubic feet of space for the heating season. When large batteries of boilers are in use it will thus be seen that they are capable of bringing in a large income. In a village lighting plant where steam is supplied only during certain hours, the exhaust may be supplemented by live steam during the rest of the time, thus keeping boilers and men in continuous service. The same practice holds good in lighting plants in large cities, and the heating becomes an important feature of the business. In railway plants, or railway and lighting combined, where the engines run continuously, but little live steam may be required. One such plant, two years ago, constructed two miles of mains under the "Holly system," and has since extended its lines. The company is heating about two hundred customers, and doing nearly all this work with exhaust steam. In the coldest weather some live steam may be required, which is regulated by an automatic device. This branch of the business has proven very profitable and has made the whole enterprise an assured success. Several smaller exhaust steam plants are in operation and all are represented as being eminently successful.

This system is now being installed in many central stations by the American District Steam Co., of Lockport, N. Y. The success of these plants is attested by from 40 to 50 central stations already so equipped.

We have attempted to give but an outline of this plan, which is somewhat of an innovation, and for this reason, perhaps, the electric companies have been rather slow to put it in practice, or else have been but imperfectly informed in regard to it. But when we consider the fact that every electrical company has the machinery for a heating plant and a supply of steam to deliver into the mains practically free of cost, and that it lacks only the mains for distribution, this utilization of the waste steam ought to be seriously considered by station managers as a promising method for obtaining increased revenues from their stations.

WORKING ANNUNCIATORS AND BELLS FROM STREET CIRCUITS.

BY

W. M. Miner

MR. ARMSTRONG'S excellent article on "Improvements in Annunciator and Bell Work," in your issue of Dec. 23, is very much to the point, ~~as~~ such work is often merely thrown together in an anything-will-do-for-this fashion.

His method of supplying the necessary current for annunciator and bell work is good; but why not go further and use current from the light circuits direct, without the intervention of any *moving* parts? Current could be supplied for this purpose direct from the light mains, through two 50 or 100 c. p. lamps, and connecting each of the bell wire mains through a lamp to one of the light mains. This would give sufficient current to work any ordinary annunciator or bell. By different combinations of lamps one could get nearly any amount of current desired. Very heavy bells could be made of high enough resistance to work from the light circuit without any interposing resistance.

Burglar alarms can also be worked on this principle, throwing on all the lights in the house as an alarm, if desired.

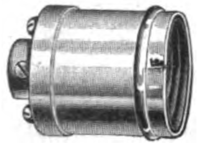
The motor-dynamo is, I think, of more importance to small telegraph offices, where the battery power required is not sufficient to warrant the installation of an isolated plant, and where current to run the motor-dynamo can be procured. It takes but a very small machine to take the place of 1,500 cells of battery, as I know from experience in Minneapolis during the past summer, on the lines of the North American Telegraph Co. with a Crocker-Wheeler $\frac{1}{6}$ h. p. motor, wound to be used as a dynamo. I worked four heavy wires between Minneapolis and Chicago, a distance of 500 miles, and two short ones, all from this small dynamo at the same time, and did it as well as, or better than, the 1,000 or more cells of gravity battery that the dynamo displaced.

RECENT EDISON LAMP SOCKETS.

INCANDESCENT lighting has developed not a few features of special interest, and prominent among these are the lamp sockets, of which there are to-day a great variety on the market, differing in shape, design and purpose, and covered, it is said, by at least 300 patents. We illustrate on this page three of the recent Edison sockets, the features of which are such as to command general interest.

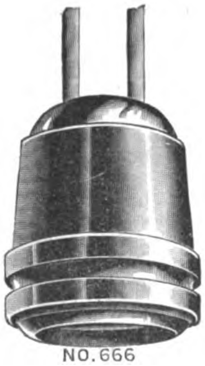
The Edison socket, born at almost the same time as the incandescent lamp, has followed with but slight deviation a straight evolutionary line. The key socket still retains the familar feature of the spring tongue brought down on the lamp tip by the pressure of the key, and making a sliding contact. It is an instantaneous switch of almost perfect type, and in its new brass casing is attractive among sockets. This key socket, however, did not fill all the requirements; to turn on the light or extinguish it demands in certain cases a pair of hands, and busy men are prone to consider the employment of two hands for so slight a task as one hand too many. Another socket has, therefore, lately been devised—the "pressure" or "push-button" socket. The circuit is made by pressure on a small button at the side of the socket, which brings a contact-piece between four phospor-bronze brushes set in a circle in the interior, but on the other side of the socket. The lamp tip makes an ordinary contact with the tip at the top of the socket screw shell. The button is retained in position by a little catch. On pressing this catch the button is released, thrown out by a spring, and the contact is broken. This socket is used mostly on flexible cords and other single light pendants, although it is also used instead of the key socket in other positions.

Recognizing the fact that their ordinary keyless socket was not always suitable for fixtures of an artistic character, the Edison Company have designed a smaller socket. It is about half the size of the well-known keyless socket, and is compact in structure and neat in style. It is claimed that there is not on the market any other socket for lamps of 16 c. p. and upwards as small as this, nor one that so well serves the purpose for which it was invented.



The other sockets and receptacles of Edison make are already well known to all who have had anything to do with the practical working of electricity in this country. But there is still another socket not yet mentioned, viz., the No. 666 Weatherproof Socket. The outside shell of this is of hard rubber, the interior parts being imbedded in insulating material capable of resisting the disintegrating effects of moisture and steam. This socket was designed for use in brew houses, dye houses and other such positions, and has even been used successfully in railway tunnel lighting and in mines.

The insulation in all these sockets, with the exception of that last named, has hitherto been of the best insulating material to be found, but now that a regular porcelain factory has been established at the Schenectady works of the company, the insulation will be of hard white vitreous porcelain there made and impervious to the influences which affect many forms of insulating material.



Letters to the Editor.

CATALOGUE AND PAMPHLETS WANTED.

I AM instructed by a foreign government to ask through your columns for catalogues and other illustrated matter describing the most modern instruments and machinery used in telegraphy, telephones; obtaining light and power from waterfalls, oil engines, etc.; and also applications of electricity to naval and military purposes, and to chemical industries such as tanning. Postage must be prepaid. Samples and photographs should be sent where possible. Samples and prices of subterranean telegraph line are particularly required.

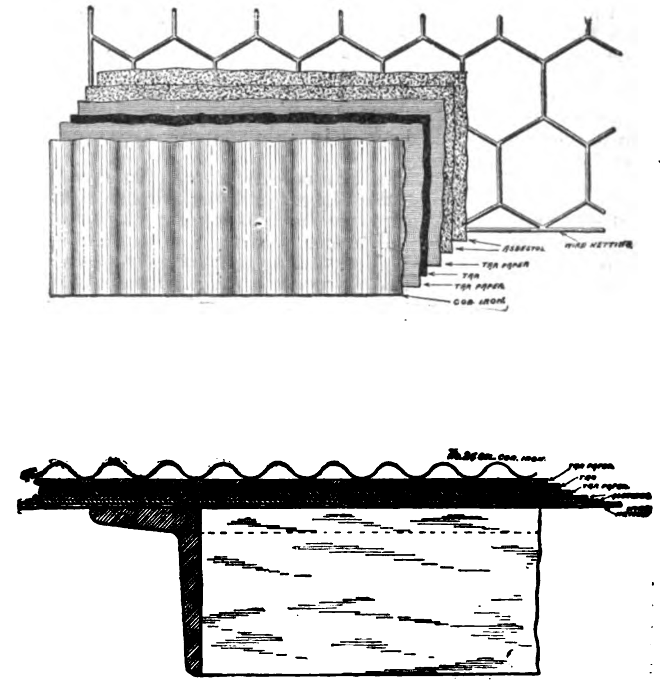
C. PURCELL TAYLOR, D. Sc.,
Patent Expert.

57 CHANCERY LANE, LONDON, ENGLAND,
Jan. 6th, 1892.

METHODS FOR OVERCOMING CONDENSATION INSIDE IRON ROOFS.

WE notice the communication of Mr. Alfred Braddell, electrical inspector, Underwriters' Association, Middle Department, Philadelphia, Pa., in your issue of Jan. 6th, and beg to say in reply to same that there are a number of ways to overcome the condensation he complains of on the underside of the corrugated iron.

This is caused more particularly in cold weather by the warmer air inside the building, condensing on the under side of the corrugated iron, which is of a lower temperature, and this can only be overcome by placing some non-conducting material between the corrugated iron and the inside of the building. The ordinary way to prevent this condensation is to place plank directly on the purlins, cover it with tar paper and then lay the corrugated iron directly on top of this, which is probably the most economical way, but it does not make the station absolutely fireproof. We have also used fireproof non-combustible boards about ⅞ in. in thickness, secured to purlins, and on top of this laying tar paper, and then our corrugated iron. Examples of this construction can be seen in the station of the Lynn Gas and Electric Light Company, at Lynn, Mass.; also on the foundry of the Pratt & Cady Co., of Hartford, Conn.; the power house of the Newport News Ship Building, Dry Dock and Construction Company, of Newport News, Va., and the machine shop for the Upson Nut Co., at Unionville, Conn., also several other buildings.



Patented.

FIREPROOF ROOF SHEATHING FOR PREVENTING CONDENSATION OF MOISTURE.

There is still another method which we have used with great success on three of the largest electric light stations in this country, namely, the United States Electric Lighting Co., of Washington, D. C.; the Narragansett Electric Lighting Company, of Providence, R. I.; the Pawtucket Gas and Electric Light Co., of Pawtucket, R. I., and also on our new shops at East Berlin, Conn., which although slightly more expensive than the other constructions described, still has the merit of being thoroughly fireproof and also preventing any condensation.

This method is described as follows: Galvanized iron wire netting with a small mesh is first tightly stretched and secured to the purlins of the roof. On this we place two thicknesses of asbestos paper board and on this two thicknesses of tar paper, being careful to make good laps and breaking joints. On top of this is placed the corrugated iron securely attached to the iron purlins. The accompanying cut will show the general idea, although in practice it varies somewhat from the method as there shown.

This makes a neat, substantial fireproof sheathing and has proved a success in practice. We would be pleased to enter into communication with any electric light company wishing further information in regard to this work.

The Berlin Iron Bridge Co.
Burr K. Field,
Vice-President.

East Berlin, Conn., Jan. 9, 1892.

LONG-DISTANCE TRANSMISSION OF POWER IN CHICAGO, WITH SPECIAL REFERENCE TO NIAGARA.

The distance that power can be electrically transmitted today is governed by the voltage that can be manipulated in the generators, motors, and on the line. With the alternating current the use of 20,000 volts is approaching a commercial stage, notwithstanding the induction in neighboring metallic bodies. There is no evidence, however, of a continuous current of this pressure being used, the nearest approach being the arc current, which years have demonstrated to be of very easy management. Is it not certain that owing to this ease of operation the high-pressure continuous current will be the future medium for electric power transmission? The limit to the pressure to be used is the sparking distance between the two conducting mains. The ordinary condenser or Leyden jar with naked conductors at 100,000 volts discharges within six inches; it is such a voltage or higher but with insulated conductors, that may be assumed a possibility. This leads into the region of the potentials of static electricity.

Suppose at Niagara there be a condenser of sufficient capacity to absorb the power of the Falls, then, if discharging wires be carried 500 miles to Chicago, we have the means of conveying the power of Niagara this distance. With the Leyden jar it should be noted, as mentioned before, that naked discharging wires are used, and one well-insulated wire only is required, the earth being used as a return, but for absolute safety two mains are preferable.

Five hundred miles of No. 0000 wire would cost about $528,000 and would transmit 3,000 h. p. at a loss of 4 per cent.; that is, 3,125 h. p. furnished at Niagara would deliver 3,000 in Chicago; this at a potential of 100,000 volts.

By using a highly insulated transmission wire, the voltage might be raised to 1,000,000 volts, and along a No. 0000 wire, at this potential 31,000 h. p. would be transmitted with a loss of less than ½ per cent.; 1 ampere at 1,000,000 volts would transmit 1,250 h. p. The generating and motor machinery for these high potentials is of the simplest character, and details will be published as early as possible.

The crux of the whole question lies in the production of a cable that will carry a high potential Leyden jar discharge. The current would be a veritable flash of lightning. Michael Faraday remarked that the current required to decompose a drop of water, was sufficient to make a thunderstorm; this is about to be realized.

The Leyden jar has already been used for exploding fuses in mines, one terminal being connected with the earth, the other with a gutta-percha-covered wire; it has also been used for telegraphing across the Thames. These instances are not referred to with the idea of actually using condensers, but, as showing an actual employment of high potentials in a limited way. The generators and motors contemplated are continuous-current machines of ordinary type, but specially wound and arranged.

George Edensor Dorman.

THE LIMITS OF FAST LOCOMOTION.

I observe that one of your estimable contemporaries devoted to railway matters has been collecting the opinions of a number of prominent experts as to whether a speed of 100 miles per hour is ever likely to be reached by passenger trains in this country. Bridge Engineer Thompson of the New York Central thinks that such a result is bound to come in the natural order of things, if the doctrine of evolution holds true in railway progress as in other things. General Manager Layng of the West Shore, too, seems to regard it as a possibility. Another G. M., whose name, out of consideration for the future feelings of his family and friends, I forbear to mention here, replied to the effect that no one with common-sense would ever run a train 100 miles per hour.

Now it won't do to be too sure about these things. I have in my library a valuable work on "The Internal Navigation of the United States," printed in Philadelphia in 1830, by Lydia H. Bailey, which contains, among other matters of interest, a report by "State Chief Engineer" C. Crozet, of Virginia, dated July 1, 1826, in which the comparative advantages of railways and canals receive an able and exhaustive discussion. In summing up the conclusions arrived at, "it will be sufficient to observe," says the State chief engineer, "that railways are advantageous only when *great speed* is a desirable object," and on this head he further remarks: "By increasing, therefore, the velocity of the rim of the wheels *by any means whatever*, the speed of transportation might be increased *without limits*, by a propelling steam engine. Prudence alone fixes a limit to the velocity; a great swiftness on a straight road might occasion very serious accidents, but on curves it would be particularly dangerous. It seems admitted that a rate of speed of more than 6 miles an hour would exceed the bounds set by prudence, though some of the sanguine advocates of railways extend this speed to 9 miles an hour." But the State chief engineer is evidently somewhat distrustful of the notions of these ultra-progressive persons, for he remarks in another part of his report that "the railroad cause itself has suffered injury throughout the last year or two by a premature zeal in its partisans," and he thinks that "it may with confidence be affirmed that the canal system in this country is not likely to be superseded by that of railroads, as by some advocates of this latter was at one period not long since contended must be the case." Three years later George Stephenson's "Rocket," the prototype of the modern locomotive, astonished the engineering world by a speed of 29 miles per hour.

The developments of the past few years have conclusively established the correctness of one of the State chief engineer's conclusions, viz., "prudence alone fixes a limit to the velocity," for at least it is no longer limited by the capabilities of a "propelling steam engine" which has to be carried upon the train.

Franklin L. Pope.

New York, Jan. 11, 1892.

A NEW ARGUMENT FOR IRON ROOFS.

In regard to iron roofs for electric light stations, they are valuable for fire protection from outside sources. In my experience with the dampness during cold weather, I found it necessary to put in a wooden ceiling with an air space between the ceiling and the roof; it also became necessary to wainscot the side stone walls for the same reason, an air space of two inches being left between the walls and the wainscoting.

Brush Electric Light Co.,
Rochester, N. Y., Jan. 11, 1892.

Geo. A. Redman,
Supt.

IRON ROOFS FOR LIGHT AND POWER STATIONS.

My attention has been called to a request for information in your recent issue from Mr. Braddell, of Philadelphia, as to "the best means of obviating this trouble (rapid condensation from iron roofs in cold weather in electric light and power stations) as it appears to be one of no little importance." I would suggest that the remedy is so simple that I am surprised that one who lives in Philadelphia, near Cramp's ship yard, should not be aware of it.

Two years ago I had the privilege of thoroughly examining some of our new United States cruisers, and was struck with the roughness of the paint on the inside of the steel shells or bottoms of the ships. On inquiry, I was informed that this roughness was purposely contrived by the mixture of ground cork and lead paint to prevent condensation and moisture. In accepting the courteous invitation of the admiral for a short voyage of 20 hours along the coast, we were blessed with a dense wet fog, during which I observed that there was no more moisture inside the ship than in an ordinary vessel, and that there was no condensation on the inside of the iron hull even down below the water line, as I several times discovered by passing my hand over the painted iron work.

In planning a new electric light station for the Brookline Gas Light Company I was extremely anxious to avoid the risks of fire, and concluded to have the plan embrace an iron roof covered with slate. In carrying out this plan I borrowed the above-named experience and have just completed the painting with a coat of cork the under side of the iron and slate roof. We had difficulty, owing to inexperience in getting a sufficient amount of cork to adhere to the roof, the surface of which measures nearly 80 squares (10 feet x 10 feet is this square measurement).

It required four coats of lead paint and about 10 bushels of ground cork, but the result is fairly good in getting a roughened surface. I presume the theory of absence of condensation is explicable by the fact that the cork contains so much air between the cold iron and the warm air that there is no direct contact between the two, and a consequent avoidance of condensing surface. In any event during the cold weather of the past 10 days, the inside surface of the slate and iron is dry, though the large building, 120 feet x 90 feet, has been kept well warmed by steam pipes running along the inside of the three outer brick walls. In the attached boiler room, not by any means kept warm, the condensation from the under surface of the slate and iron roof is strongly marked.

BROOKLINE GAS LIGHT CO.,
BROOKLINE, MASS., Jan. 9, 1892.

ROBT. AMORY,
Pres. and Man.

AN INDICATOR FOR CALCULATING HORSE-POWERS.

I HAVE just had brought under my notice an article in your issue of Nov. 18, 1891, by Mr. Francis R. Hart, on "The Determination of the Available Energy of Water Powers," with a diagram assuming 75 per cent. of the total energy of such water powers as the efficiency.

I have brought out and supplied a good many indicators for obtaining the horse-power of water wheels or turbines, but with the advantage that they carry the falls from 2 to 200 feet, and give the horse-power from 1 to 1,000, and that, with *any percentage* of the total energy from 50 to 100 per cent. The results are also much easier to read than with a diagram, being given by discs with graduated scales ; the former are always more or less tedious to read off.

A description of a similar indicator for obtaining the horse-power of a steam engine was published in the November number of *The Compass*, which may perhaps interest your readers. I have also made these indicators to give the horse-power of a waterfall issuing from a *jet*, from $\frac{1}{10}$ inch to 6 inches diameter, with any rate of useful effect.

WM. COX.

New York, Jan. 13, 1892.

Reports of Companies.

THE CROCKER-WHEELER ELECTRIC CO.

ON December 1, 1891, all the interests owned by the Crocker-Wheeler Motor Company were bought by the Crocker-Wheeler Electric Co. and the capital stock was increased from $100,000 to $200,000. At the annual meeting held Jan. 13th the following officers were elected :

President, S. S. Wheeler; vice-president and treasurer, F. B. Crocker; secretary, D. H. Jeffery; directors : R. M. Peterson, David Crocker, W. B. Baldwin, A. Foster Higgins, F. M. Jeffery.

The company was awarded a gold medal at the electrical exposition recently held at Augusta, Ga., and attractive exhibits are now being made at the Crystal Palace, London, Exhibition, and at New Haven.

Among the new articles recently put on the market by them is an automatic switch of very substantial character. Their new fan-motor, which at the same time revolves a fan and rotates on a pedestal, is proving a decided success. Extensive additions are now being made to their factory, and the business of the company bids fair to be very largely increased the coming year.

Literature.

The Galvanic Circuit Investigated Mathematically. By Dr. G. S. Ohm, Berlin, 1827. Translated by William Francis, with a preface by the editor, Thomas D. Lockwood. *New York, D. Van Nostrand Company*, 1891. Science Series. Price, 50 cents.

ALTHOUGH Ohm's law forms the basis for most of our theory and calculations in electrical work, there are comparatively few who take the trouble to go back to the original source of information and to study the memoir which Ohm has left as an enduring monument to his fame. We use the word "trouble" advisedly, because the only previous translation of Ohm's great work is to be found in *Taylor's Scientific Memoirs*, to which but comparatively few have access, and, as the original work itself has become a much-prized rarity, few have undertaken the task. Its publication in this handy form will, we are sure, be welcomed by a large number of students and lovers of electrical science. We notice that the illustrations which in the original are given at the end of the work as an inset are wisely printed in the text, thus facilitating reference to them. While the work before us is not entirely free from error, the translator's task will be conceded to be no easy one. The work of the editor must, however, be commended. Mr. Lockwood's preface is an exceedingly concise statement of the work which led up to the formulation of the law by Ohm and the various annotations throughout the work aid considerably in elucidating passages by the light of more modern investigations. We can heartily recommend the little book.

A First Book of Electricity and Magnetism. By W. Perren Maycock, M. I. E. E. *London, Whittaker & Co.; New York, Macmillan & Co.* 5 x 7 inches, pp. 133. 84 illustrations. Price, $0.60.

THIS, as its name implies, is a book for beginners, treating of the kindred sciences of electricity and magnetism in their simplest and most elementary forms. Appended to each part, of which there are three, is a list of questions for the purpose of testing the proficiency of the student. The book will be quite useful.

Society and Club Notes.

BOSTON ELECTRIC CLUB.

THE Boston Electric Club held its inaugural dinner on Monday evening, the 11th inst., under its new auspices, in the Parker House. The dinner was well attended, and proved a very enjoyable affair. Before the dinner there was a short business meeting, at which it was resolved to have monthly dinners. Mr. Henry B. Cram was elected president, Mr. R. F. Ross, secretary and treasurer, and a board of seven directors was appointed. The club had for its guests on this occasion Prof. Elihu Thomson, Prof. Cross of the Massachusetts Institute of Technology, and Prof. Dolbear of Tufts College. After the dinner, which was quite a success, and was attended by about 40 members, Prof. Thomson gave a very interesting address on the recent development and progress of electricity, touching more particularly on electric railways, electric drilling and electric mining.

In the course of his remarks he said that electric engineering for large light and power stations was undoubtedly turning towards large engines directly coupled to the generator, and tending to do away with the intervening countershafting and belting. He gave also an interesting explanation of the development of the three-phase generator, referring in particular to the transmission of power at Frankfort, and the great possibilities for its development in this country with its numerous water-powers.

Prof. Cross then gave an interesting description of how electrical knowledge was carefully instilled into the student of electrical engineering at the Institute of Technology, after which Prof. Dolbear described some interesting experiments which he had recently made, to discover if there were any torsional effect in a wire when a current was passing through it. Mr. W. J. Denver and Mr. C. J. H. Woodbury then followed, and lastly Mr. George Cutter, of Chicago, gave some of the most recent news relating to the development of the electrical department at the World's Fair. Mr. Cram presided in his usual graceful manner, and a most enjoyable evening was spent. It is to be hoped that this series of dinners will be kept up and be well attended, and it is the intention of the directors to have some interesting speakers or some discussion on a live topic on each occasion, so as to make the occasions not only social, but interesting and instructive.

COMPILING THE ELEVENTH CENSUS BY ELECTRICITY.

ONE of the most beautiful and ingenious of the recent applications of electricity has been its use in the Eleventh United States Census for the purpose of counting and tabulating the returns. The apparatus used is the invention and design of Dr. Herman Hollerith, of Washington, under whose supervision it has summed up the totals of a population of 62,000,000, and has now begun to furnish a variety of interesting data as to age, occupation, resources, education, health, etc. The apparatus has also been adopted for census purposes by Canada and Austria. Dr. Hollerith is a member of the New York Electric Club, and he has now kindly consented to make an exhibit of the whole system at the club house on January 28, when the members will be able to see how electricity has been applied with wonderful ingenuity and not less extraordinary success to the intricate and complex work of counting and classifying a whole nation. This is the first time that the apparatus has ever been exhibited in public, and the great interest that has been taken in New York in census matters gives special timeliness to this meeting at the Electric Club.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

MR. GEO. F. PORTER, the secretary of the association, has issued a letter canvassing the desire of the electrical trade to make a feature of an electrical exhibition at the Buffalo Convention, Feb. 23, 24 and 25. Should enough members signify a desire to exhibit to justify the management in taking such action, space and power will be provided gratis. It is believed that while the miscellaneous exhibit of supplies will be good, no attempt will be made to repeat the effort put forth at Montreal last September.

Personal.

HON. JAMES D. REID.

THE personal friends of the Hon. James D. Reid, U. S. Consul at Dunfermline, Scotland, have been gratified at receiving from him and Mrs. Reid a beautiful new year souvenir in white and gold, printed in his own striking penmanship. On the cover in gold are three circles with the words "Fifty years" and the dates 1842–1892. Inside are several stanzas of a touching poem by Mr. Reid, who always had a weakness for elegiac and ballad verse. There is also a little steel plate of the old Scotch town, and the whole is tied with gold braid. The period named 1842–1892 covers practically Mr. Reid's active work in the telegraph field, dating from his association with Morse; and his thousands of juniors in that department of electrical industry may well hope to be as blithe and serene and active as he when they in turn have tried to emulate his career.

MR. L. W. COLLINS.

THE above-named gentleman, who is too well known in electrical circles East and West to need any formal introduction, has moved from Chicago to New York, and has become the trade editor and advertising representative of THE ELECTRICAL ENGINEER in this city. Mr. Collins will contribute the New York Notes and other items of a business and industrial nature to these columns, and the publishers ask for him from its friends, readers and patrons whatever help they can give that will go towards rendering the paper useful in furthering the interests of electrical industry.

MR. NIKOLA TESLA left for Europe on the "Umbria" on January 16, to be gone several weeks. He has been invited to lecture before the various electrical and scientific societies of the Old World, and will appear before the English Institution of Electrical Engineers at the end of this month or early in February. While abroad he will seize the opportunity to visit his mother and relatives in Smiljan Lika.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JANUARY 5, 1892.

Alarms and Signals:—

Electric Annunciator, C. Molitor, 466,357. Filed Sept. 14, 1891.

Relates to that class of annunciators having a pointer moved by operating devices controlled by an electric current.

Combined Electrical Protective and Time-Detecting System, J. S. Morse, 466,505. Filed June 5, 1891.

Consists of one or more thermostatic circuits containing alarm-bell, battery, circuit-controlling mechanism, time-detector, etc.

Electrical Signal-Box, T. F. Gaynor, 466,604. Filed Jan. 23, 1888.

A signal-box for use on fire-alarm circuits.

Multiple-Signal Transmitter, C. E Nash, 466,620. Filed May 2, 1891.

A transmitter for police-telegraph systems in which it is desired to record any desired one of a number of distinct messages from each signal-box.

Clocks:—

Apparatus for Synchronizing Clocks, L. Von Orth, 466,518. Filed Jan. 23, 1891.

Conductors, Conduits and Insulators:—

Insulator, W. S. Andrews, 466,391. Filed May 27, 1891.

A trolley hanger or pull-off for electric railways.

Extensible Electrical Conductor, B. C. Rowell, 466,427. Filed April 18, 1891.

An arrangement for bridging brakes in a trolley system as, for instance, where the line crosses a steam railway track or a drawbridge.

Insulator, G. B. Norgrave, 466,726. Filed April 9, 1891.

Consists of a pair of insulating blocks having corresponding grooves cut in their faces to hold the wire; said blocks being held together by a clamp forming part of the insulator's support.

Dynamos and Motors:—

Commutator Brush and Holder for Dynamo-Electric Machines and Motors, F. J. Sprague, 466,448. Filed Dec. 10, 1886.

Has for its object to so arrange the brushes that the armature may run readily in either direction, and also to produce a simple and efficient construction of the brushes and brush-holders.

Regulation of Dynamo-Electric Machines, R. Thury, 466,760. Filed Aug. 4, 1891.

Relates to the automatic regulation of the lead of collecting brushes on electric generators.

Galvanic and Thermo-Electric Batteries:—

Electric Battery, P. B. Delany, 466,664. Filed Nov. 13, 1890.

An improvement in the ordinary battery cell whereby the wire leading from the copper element is held in a fixed relation to the jar, and also means whereby the zinc "crowfoot" may be cleared of the ordinary formations on its lower side without in any way disturbing it.

Lamps and Appurtenances:—

Cut-Out for Incandescent Lamps, T. A. Edison and J. F. Ott, 466,400. Filed Oct. 27, 1886.

Consists of a fusible cut-out included in the base of the lamp.

Electric Switch, G. E. Painter, 466,508. Filed Mar. 17, 1891.

Consists in so constructing a switch that it shall grasp the pipe which supports a collection of lamps and be easily removable therefrom.

Electric Drop-Light, G. E. Painter, 466,509. Filed Apr. 29, 1891.

Comprises a reel by means of which an incandescent lamp may be raised or lowered at will, the flexible cord being wound upon said reel.

Electric Lamp Socket-Switch, G. E. Painter. 466,510. Filed Mar. 17, 1891.

A device for turning on or off an individual lamp from any distance within the length of the circuit.

Electric Lamp Socket-Switch, G. E. Painter, 466,511. Filed Mar. 17, 1891.

Similar in its object to 466,510.

Incandescent Lamp, P. Grant, 466,562. Filed July 7, 1891.

A lamp that may be taken apart at any time for insertion of a new filament or for other repairs without destroying any portion thereof.

Globe-Guard for Electric Lights, C. P. Robbins, 466,576. Filed May 11, 1891.

Metallurgical:—

Ore-Separator, C. J. Reed, 466,513. Filed Oct. 13, 1890.

Ore-Separating Machinery, C. J. Reed, 466,514. Filed Dec. 1, 1890.

Ore-Separator, C. J. Reed, 466 515. Filed Apr. 6, 1891.

Miscellaneous:—

Device for Electric Elevators. R. C. Smith, 466,447. Filed Mar. 17, 1891.

A safety switch for electric elevators.

Damper Controller, J. V. Stout, 466,450. Filed Mar. 23, 1891.

An automatic controlling device for heating apparatus in buildings.

Art of Electrolytic Decomposition, T. A. Edison, 466,460. Filed May 26, 1882.

Process of decomposing substances consisting in subjecting them to the action of an electric current while under great pressure and high temperature.

Electric Reciprocating Tool, H. N. Marvin, 466,541. Filed June 6, 1888.

An electric drill of similar device actuated by pulsating currents.

Electric Push, J. F. Wollensak, 466,644. Filed Oct. 23, 1891.

Electric Meter, C. K. Huguet, 466,686. Filed Dec. 3, 1890.

Safety Fuse for Electric Conductors, J. A. Wotton, 466,761. Filed Oct. 12, 1891.

A safety fuse employing an explosive sufficiently violent to blow out any arc that might form between terminals on the fusing of an ordinary safety plug.

Multiple Switchboard Busy-Test Circuit and Apparatus, F. A. Pickernell, 466,702. Filed Aug. 17, 1891.

A completely localized test arrangement, *i. e.*, one that shall be entirely insulated from the line circuit.

Railways and Appliances:—

Electric Railway Crossing, W. Osner, 466,262. Filed Oct. 16, 1890.

Provides means for the crossing of electric railway conductors and for maintaining the line uninterruptedly across drawbridges, etc.. without loss of current by induction or danger of breaking the circuit.

System of Electric Distribution for Railways, N. W. Perry, 466,367. Filed Mar. 2, 1891.

Relates to the distribution of electricity by a current which remains constant in quantity, while the translating devices are arranged in series with one another and with the generator or dynamo.

System of Electric Distribution for Moving Translating Devices, N. W. Perry, 466,368. Filed April 2, 1891.

Similar to No. 466,367.

Underground Conduit for Electric Railways, C. P. Tatro, 466,471. Filed Nov. 14, 1891.

Provides means for obtaining continuous electric communication between an insulated line wire and the cars, and also means for perfectly insulating said line wire and temporarily communicating with segments thereof without exposing any portion of said line wire.

Circuit Controller, H. P. White, 466,519. Filed April 29, 1891.

Has for its object a construction whereby the natural yielding of a rail in a railway track operates a circuit controller of an electric circuit.

Car Truck for Electric Railway Cars, P. M. Kling, 466,539. Filed Dec. 26, 1890.

A car truck especially adapted to the convenient mounting of railway motors and mechanism.

Lubricator for Trolleys, E. M. Doig, 466,737. Filed Aug. 17, 1891.

A self-oiling journal for trolleys.

Telegraphs:—

Cable Telegraph, W. E Facer, 466,492. Filed Dec. 22, 1890.

Has for its object to overcome difficulties experienced in long-distance ocean cable lines arising from induced currents, etc.

Telephones and Apparatus:—

Magneto-Telephone for Personal Wear, A. E. Miltimore, 466,725. Filed Feb. 24, 1891.

Legal Notes.

DISSOLUTION OF A TEMPORARY INJUNCTION AS TO EDISON STOCK.

JUDGE BARRETT of the New York Supreme Court has dissolved a temporary injunction obtained by Martin A. Frank against the Edison Electric Light Company restraining it from declaring a dividend of 80 per cent., payable in bonds of the company. This decision is rendered upon the point raised by the defendant that Frank should should seek relief in a separate action, and not in his present suit against the company. The injunction is dissolved without prejudice to an action to secure the relief prayed for.

Judge Barrett says in regard to his recent decision upholding the dissolution: "I did not mean to be understood as asserting that a corporation could not under any circumstances distribute its surplus earnings through the instrumentality in part of bonds issued to represent such earnings. There may undoubtedly be circumstances which would justify such an expedient for temporary purposes. And indeed it might be made to appear that such bonds simply represented surplus earnings, and could not possibly impair the actual capital of the company. But I have not changed my opinion as to the scheme here sought to be begun. In my judgment the affidavit of defendant does not justify the issuing of these debenture bonds upon the collateral security of stocks and bonds of the subsidiary companies for the purpose of raising money to declare a dividend upon the stock of this defendant."

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The man who steadily advertises never misses business because his " wires are down."

THE G. S. A. LINE WIRE HOLDER.

"SIMPLE and cheap" are the qualities aimed at in this new device. Keeping the same insulators as are now in use both for telegraph and electric light and power transmission, this invention consists of a neck-band sprung into an annular groove of the insulator, a U-shaped lever pivoted to the neck-band and provided with eyes and a fastening bail or link that is pivoted to the eyes and provided with a bent or hook shaped portion for engaging the line wire. The bent portion presses the wire, when the lever is swung in a downward direction, into the annular groove of the insulator, so that the rounded end of the bail forms a continuation of the neck-band, in which position the line wire is firmly locked to the insulator. The wire members of the fastening device can thus be readily opened or closed so as to permit the insertion or removal of the line wire to or from the hook-shaped bail and the attaching and detaching of the same to the insulator, thus facilitating by a great deal the stringing or repairing of telegraph and electric light and power lines.

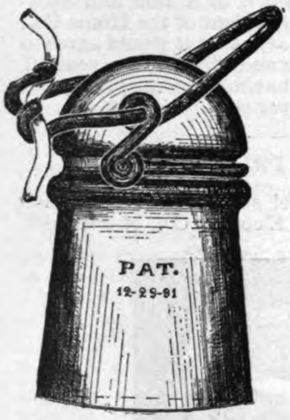


FIG. 1.—TELEGRAPH OR TELEPHONE WIRE.

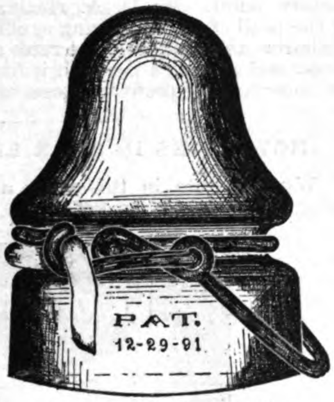


FIG. 2.—LIGHT AND RAILWAY FEEDER WIRE.

The practical lineman needs this device which was invented and patented by G. Sacco Albanese, formerly of Orange, N. J., now of Lynn, Mass.

PERRET MOTORS IN NEWSPAPER OFFICES.

In our issue of January 6 we gave an illustration of the Perret motor in the printing office of the New York *Commercial Advertiser*. We now publish an interesting letter from the *Lancaster Era*, of Lancaster, Pa., with regard to the plant that it has had in operation for over a year:

OFFICE OF THE "NEW ERA"
(Daily and Weekly),
WARFEL & GEIST, 41 No. Queen Street,
LANCASTER, PA., Jan. 1, 1892.

MR. E. H. CUTLER,
Manager the Elektron M'f'g Co.

DEAR SIR—One year ago we substituted electrical for steam power in the *New Era* printing house. A 20 h. p. Perret motor furnishes power for the machinery in the main press-room, driving a Goss perfecting newspaper press, with double folder, an Adams and three cylinder book presses, freight elevator, and the machinery in stereotype foundry.

A ten-horse Perret furnishes power for the half dozen presses and other machinery in the jobbing department, with ample reserve power for increase of both plants. The performance of these motors has been satisfactory in all respects. They run free from sparking, maintain a uniform speed under all variations of load, and cost nothing for engineering. We would not exchange for steam power upon any consideration. They are always ready for duty at any hour of the day or night without waiting to "get up steam." Steam for drying matrices is furnished by Murray's generator and steam table combined, which is both economical and convenient. As you are aware, we selected the Perret motor from a number of competitors because, while equal to the best in points in common, it was the only one which developed its maximum power at such slow speed as enabled us to run our line shafts without the intervention of counter-shafting.

The experience of a year fully confirms our judgment in the selection of these machines.

Yours truly,
(Copy). WARFEL & GEIST.

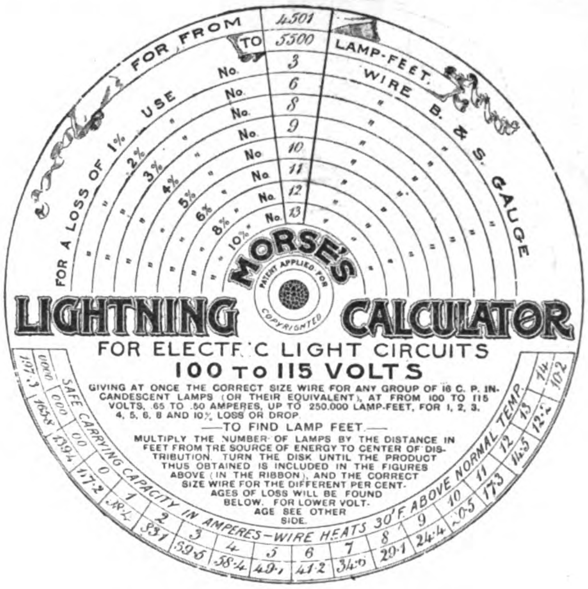
WAGNER-QUEEN VOLTMETER.

A FEW weeks ago we described the new portable voltmeter bearing this name, and which has been placed on the market by Queen & Co., of Philadelphia. The prominent features of this instrument are such as to render it of great value to electricians for measuring both alternating and direct current. It is very portable, weighing only 22 ounces, and the dimensions of the case are 7¾ by 4 by 2 inches, so that it can be carried in a good-sized pocket. The pointer is dead beat and direct reading, and the indications are accurate within one per cent. The price is also very low, which is of importance to those purchasers who may not feel warranted in buying the more elaborate and standard Cardew type. We are informed by the makers that up to date the demand has far exceeded the supply of these voltmeters. A large quantity is being pushed through their factory and they hope soon to keep up with the orders as received, so that delays in shipment will not occur. It will be well for those in need of a good portable voltmeter for both alternating and direct currents to obtain a copy of circular No. 265 from Queen & Co.

MORSE'S LIGHTNING CALCULATOR FOR ELECTRIC LIGHT CIRCUITS.

ONE of the most useful as well as unique devices to which we have called the attention of our readers is "Morse's Lightning Calculator" for electric light circuits, an illustration of which accompanies this article. This invention will readily commend itself to all those interested in electricity on account of its extreme simplicity and the readiness with which all ordinary problems of house wiring may be solved. It is quicker and more easily consulted than a chart or table as there are no intersecting lines to follow or columns to confuse. The readings are direct, plain and absolutely correct. It is sometimes desirable to ascertain the proper size wire to use for certain circuits in places where it is inconvenient to spread out a chart or consult a table, but this calculator may be consulted anywhere during the progress of work as well as in the office. It can be carried in the pocket and gives instantly the information desired. The calculations are for 50 to 60 volts, 1 ampere on one side, and for 100 to 115 volts, .65 to .50 amperes on the other, and range from 0 to 250,000 lamp feet, with from 1 to 10 per cent. drop or loss. This meets the requirements of all ordinary installations.

By consulting the cut below it will be readily understood how if "You turn the disc, it does the rest." Suppose the problem is to install 50 16 c. p. 110-volt lamps with a loss of 5 per cent., at a distance of 100 feet from the generator or source of energy. Multiply the number of lamps (50) by the distance in feet (100) (see rule on calculator) and we have 5,000 lamp feet. The calculator as it stands in our illustration reads "For from 4,501 to 5,000 lamp feet, etc." Five thousand is therefore included in these figures, and by noting the figures opposite the 5 per cent. mark, it will be seen that No. 10 wire B. & S. gauge is the proper size wire to use.

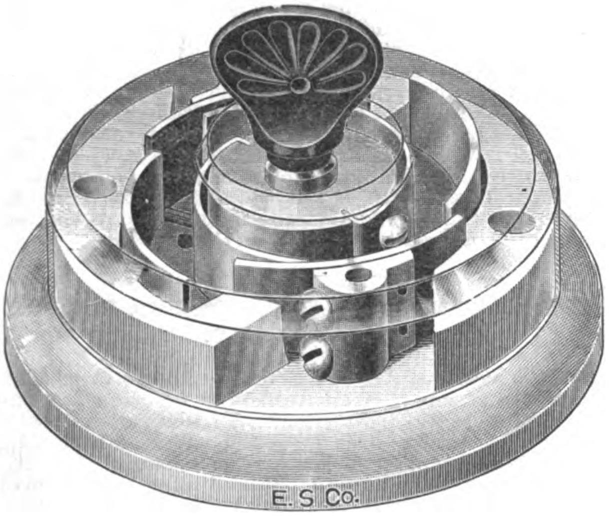

FOR FROM 4501 TO 5500 LAMP-FEET.
FOR A LOSS OF 1% 2% 3% 4% 5% 6% 8% 10% USE No. 3 6 8 9 10 11 12 13 WIRE B. & S. GAUGE
MORSE'S
PATENT APPLIED FOR
COPYRIGHTED
LIGHTNING CALCULATOR
FOR ELECTRIC LIGHT CIRCUITS
100 TO 115 VOLTS
GIVING AT ONCE THE CORRECT SIZE WIRE FOR ANY GROUP OF 16 C. P. INCANDESCENT LAMPS (OR THEIR EQUIVALENT), AT FROM 100 TO 115 VOLTS, .65 TO .50 AMPERES, UP TO 250.000 LAMP-FEET, FOR 1, 2, 3, 4, 5, 6, 8 AND 10% LOSS OR DROP.
—TO FIND LAMP FEET.—
MULTIPLY THE NUMBER OF LAMPS BY THE DISTANCE IN FEET FROM THE SOURCE OF ENERGY TO CENTER OF DISTRIBUTION. TURN THE DISK UNTIL THE PRODUCT THUS OBTAINED IS INCLUDED IN THE FIGURES ABOVE (IN THE RIBBON), AND THE CORRECT SIZE WIRE FOR THE DIFFERENT PER CENTAGES OF LOSS WILL BE FOUND BELOW. FOR LOWER VOLTAGE SEE OTHER SIDE.
SAFE CARRYING CAPACITY IN AMPERES—WIRE HEATS 30°F. ABOVE NORMAL TEMP.
0000 197.3
000 165.8
00 139.4
0 117.2
1 98.4
2 83.1
3 69.5
4 58.4
5 49.1
6 41.2
7 34.6
8 29.1
9 24.4
10 20.5
11 17.3
12 14.5
13 12.2
14 10.2

MORSE LIGHTNING CALCULATOR.

The time-saving qualities, together with the accuracy insured by the use of this device, makes the price of 50 cents at which it is sold appear very low. It has been placed on the market by Edward Lasell, N. Y. Life Building, Kansas City, Mo.

A NEW WIRT SNAP SWITCH.

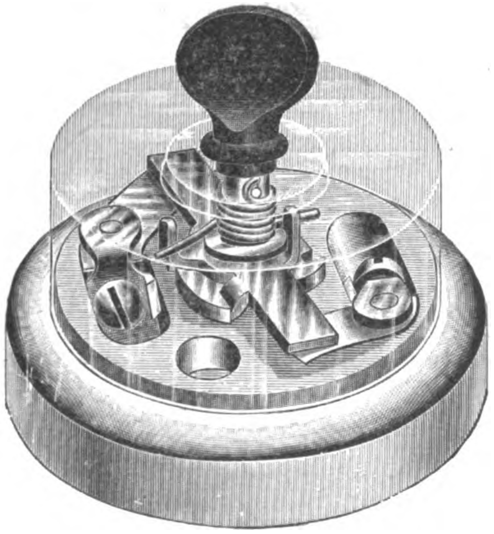
It would seem that the field was pretty well covered in the way of switches and other devices for interrupting or controlling electric currents. But about the time we have settled down to the conviction that the thing is done, and well done, we discover that there are other and probably better ways of doing it. The snap switch shown in the illustration is the design of Mr. Charles Wirt and embodies some distinctively new ideas while it accomplishes the purpose simply and satisfactorily. This is clearly seen by reference to the cut. It is of small size but has a large carrying capacity as it will break the full current of 220 volts without injurious sparking. It is very neat in finish and appearance and is made by the Electrical Supply Co., Chicago.



New Wirt Snap Switch.

THE ACME SINGLE POLE DOUBLE-BREAK SWITCH.

The Electric Appliance Company, of Chicago, are placing upon the market a new double-break switch, which it is claimed combines all the desirable points which can be suggested for an incandescent snap switch, at the same time doing away with the many bad features commonly found in others. The Acme 10-ampere switch measures less than three inches over all and has but two working parts. It is operated by a thumb-piece which unscrews when turned backwards and its action is easy and positive. The wide double break which, combined, measures more than 1¾ inch, will break several times the voltage in ordinary use, thus insuring long life to the switch. The motion of the bar passing over the flexible bronze brushes always keeps the contact surfaces clean and bright. There is embodied in this switch a unique device which is very simple and absolutely mechanical. This releases the bar at the proper time and also prevents it from being turned backwards. The Acme does not depend in the least upon friction between any of its parts to retain the bar until the handle is given the required turn to release it.



The Acme Single Pole Double-Break Switch.

Several new features have been introduced in the construction of the Acme switch which are strongly recommended by first-class line men, including among them being the manner of making connection by means of which the wires entering the switch are always open to inspection and require no extra perforations in the base for their admission to the terminals.

THE ELECTRIC MUTUAL INSURANCE CO.

The announcement is made that the directors of the above company have executed a contract whereby the entire liability under all of its outstanding policies is assumed by the Home Insurance Co., of this city, a strong organization with ten million dollars of assets. The Home Co. will have the benefit of the expert services of Mr. S. E. Barton and Capt. W. M. Brophy, whose work for the Electric Mutual has been so effective in bringing insurance rates on electric plants down to a fair and satisfactory point. Mr. D. A. Heald, the president of the Home Co., at the head of the reinsuring syndicate says that it would agree to authorize a reduction in the rates at the end of, say, two years if at the end of such a period it is found that the existing rates yield an underwriting profit in excess of ten per cent.

NOVELTIES IN STAR ELECTRIX SWITCHES.

We illustrate in this issue a novel switch, Fig. 1, which is being put upon the market by the Star Electrix Co., of Philadelphia. This switch is intended to go into a panel or wall, and, as will be seen, instead of protruding, as is the case with ordinary switches, the handle or button is set in a recess so that the end comes flush with the wall.

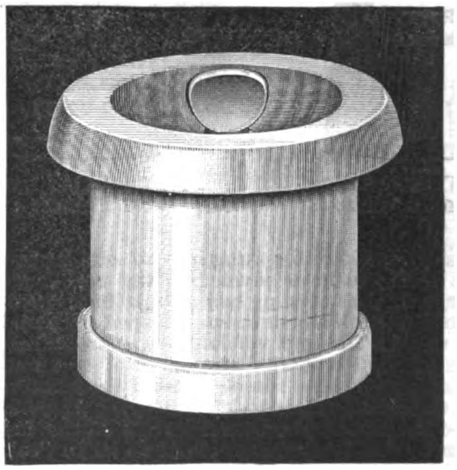


Fig. 1.—The Star Electrix Wall Switch.

We also show, Fig. 2, an interior view of the improved construction of the well-known 10 amp. S. P. Electrix switch. The handles have a large flattened metal nut in their interior, making it impossible to break or twist them off, while the wire connections are provided with a very convenient set-screw.

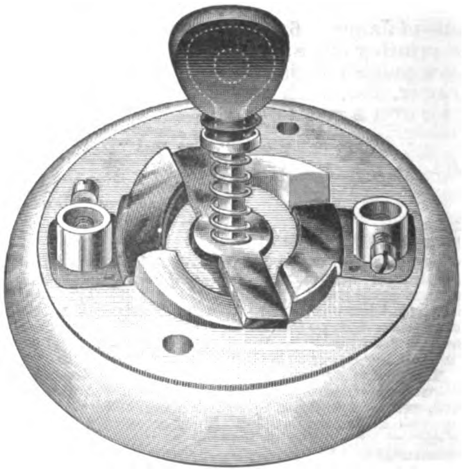


Fig. 2.—The Star Electrix 10-Ampere Switch.

LIGHTING CHICAGO'S ALLEYS.

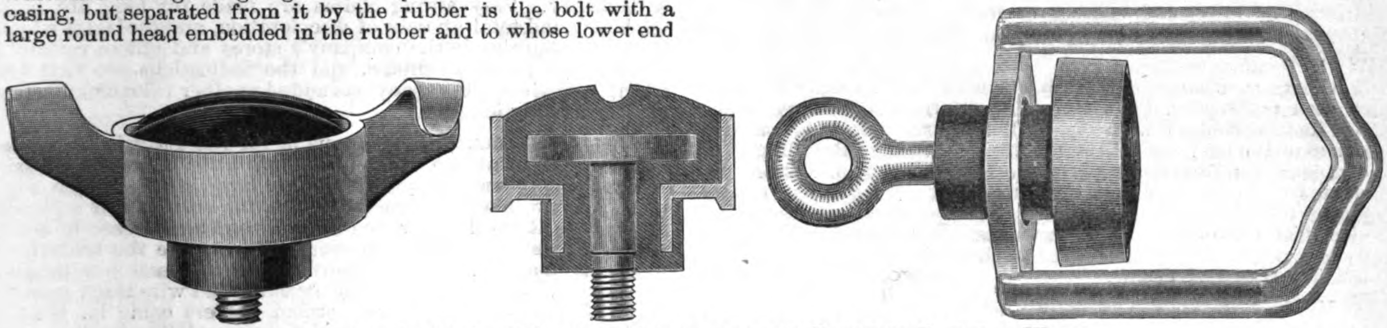
Major McClaughry, Chief of Police of Chicago, in an address at the banquet of the Methodist Social Union, recently made this statement: "Vice flourishes in darkness, and if a 20,000 c. p. arc light was placed in every alley on the South Side of Chicago, more good would be done than if the police force was trebled."

OLD RAILS AS TELEGRAPH POLES.

Old rails are used for telegraph poles in India. Two short pieces of rail are bolted to the foot of a long rail and the ends are buried in the ground. The bracket is of wrought iron, with the ends turned up for the insulators. The cost is less than half of that of wooden posts.

THE "ELLIOTT" INSULATORS FOR ELECTRIC RAILWAY WORK.

The rapid development of electric railway work, with its overspreading network of overhead wires, has induced many manufacturing companies to produce electric insulating devices specially adapted for railway work. Among the most recent to be put on the market are the "Elliott" insulators, manufactured by the Revere Rubber Company, of 63 Franklin street, Boston. Fig. 1 represents the "Elliott" trolley line insulator as applied to the span wire, and Fig. 2 shows the insulating part of it in section. The insulation is composed of a special hard rubber which possesses great strength, and is at the same time tough, and not at all brittle. The outside of the insulator is made of brass, in which are the lugs for going over the span wire. Inside this brass casing, but separated from it by the rubber is the bolt with a large round head embedded in the rubber and to whose lower end is screwed the clip for supporting the trolley wire. It will be seen also that the insulation is turned up round the bottom flange of the outside casing, so that any short-circuiting by moisture is effectively prevented. Fig. 3 shows the "Elliott" pull-off, or strain insulator, the insulation of which is also made of rubber, and is in many respects similar in design to the hanger. It is extremely simple, strong, has high insulating properties, and is at the same time small and light, considering that it will stand a strain of upwards of 8,000 pounds. The Revere Rubber Company are making many other electric specialties, and their large factory at Revere, Mass., is well equipped to turn out the highest class of work in this line.



Figs. 1, 2 and 3.—"Elliott" Insulators for Electric Railway Work.

BROOKLYN NOTES.

The Citizens' Electric Illuminating Co. are making enlargements of their entire plant as rapidly as the work can be pushed. They have nearly completed an addition of 500 h. p., of the Cowles Engineering Co.'s boilers and in the spring will erect a 150-foot chimney. Drawings have been made for a very elaborate arc switchboard which is to control their 74 circuits and 60 dynamos. The circuits are completely interchangeable, and operated without the use of cables. A large alternating switchboard is also to be built.

President Huntley, of the National Electric Light Association, with several other gentlemen, looked over the electric interests of the city with Superintendent Peck, of the Citizens' Co., on January 7th.

A very cheerful and unique display is made over the station of the Edison Electric Illuminating Co. Between the two massive chimneys is suspended a large sign with these words spelled out in vari-colored lamps:

"A Happy New Year,
1892."

From Fulton street at night the effect is beautiful. This was lighted by the fire-alarm for the first time at exactly midnight on the beginning of the new year. The Edison Company will immediately install two triple-expansion, non-condensing engines of 750 h. p. each. They will be coupled direct to two Edison 300 K. W. dynamos Since January 1, forty h. p. of motors have been installed and contracts for isolated plants of 2,700 lights have been closed.

The Water Famine.—During the recent water famine caused by the breaking of a conduit in Brooklyn practically all business requiring power was suspended. The Edison Electric Illuminating Co., however, kept their entire plant running without a stop, in the following enterprising manner: Temporary leases were at once secured on all the available artesian wells. With the aid of a score of carts and an extemporized electric pump just enough water could be secured. Their own well unfortunately became clogged by sand at the outset. In this manner the company was enabled to stand the 36-hour famine, while all others were nearly shut down. The company was offered $100 for a single cartful of water by the *Brooklyn Citizen*, whose edition had got partly through the press when the famine occurred. The water was at once gratuitously given.

Street Railway Matters.—The Mayor's veto still withholds the permission granted by the common council last December to the street railways of this city, giving them the right to operate by electricity. Private consent has cheerfully been given, as well as the sanction of the State Board of Railroad Commissioners, and it is hoped that the mayor will soon withdraw his veto. In this event work will be immediately begun by several roads. The telephone company expect no serious trouble from the trolley system. They have now a large number of metallic circuits. To show the magnitude of telephone work about New York, it may be said that the exchanges within a twenty-mile radius of the city show a list of over 20,000 subscribers.

PHILADELPHIA NOTES.

Electric Club.—The question of organizing an Electric Club in Philadelphia has been agitated for a long time and ought to be accomplished. Such a club properly conducted and supported by the electrical fraternity would be a credit to the city. In order to learn what interest is manifested in such an organization the writer would ask all those who would like to participate in the forwarding of this scheme to send their names to the Electric Club, City Trust Building. If one hundred names are received, each party will be notified to attend a meeting of the whole at some hotel or other designated place.

Mr. G. H. Fisher, Philadelphia agent for Chas. A. Schieren & Co., reports an unusually large demand for the Schieren famous perforated belting. Among the electric light plants which have been recently equipped with this belting are the following: The Diamond Electric Light Co., Columbia Electric Light Co., Southern Electric Light & Power Co., West End Electric Light Co., Powelton Electric Light Co., and the plant at the Gladstone Apartment House.

The Jenkintown (Pa.) Light Co. has just placed an order with the Penna. Electric Engineering Co. for two 1,000-light National alternating current dynamos. The Jenkintown Co. already have a plant of 4,000 lights covering an area of 25 miles, and are lighting 10 stations on the Reading Railroad.

The Pennsylvania Electric Engineering Co. report large sales for their lamp, "The Pennsylvania," from all parts of the country, and from all reports they undoubtedly have one of the most efficient lamps upon the market.

F. A. La Roche, general manager of the La Roche Electric Works, was the recipient, on Christmas eve, of a very handsome solid silver service from the employees of the concern.

NEW YORK NOTES.

THE ALEXANDER-CHAMBERLAIN CO.—The system of entire plant station inspection which the Alexander-Chamberlain Co. are introducing is meeting with flattering success. The adoption of this scheme means to the company the entire supervision of the plant and the attempt to run the same in the most economical manner. Companies which have adopted the A. & C. Co.'s system of inspection have found a material decrease in the cost of running. The plants under the company's care are inspected some once and some twice each week, thus preventing the long standing of the slightest trouble. The Alexander-Chamberlain Co. have just closed a contract with the City Button Works for an arc lamp installation; also a 300 light incandescent plant with an auxiliary storage battery installation.

MR. A. J. BARON, general manager at Wellington, New Zealand, for the Gulcher Electric Light Co., of London, who is making a flying trip through this country, spent a few days in this city recently. So far as possible Mr. Baron has made at least a passing inspection of all electrical devices coming to his notice. He called at the offices of the Ongley Electric Company recently and was very much interested in their system of electric watchman's clocks and recorders, and especially in their new electric alarm for automatic sprinklers, which has been favorably spoken of by the board of fire underwriters in this city. Mr. Baron sails from here to London, thence to New Zealand.

MR. T. J. MURPHY has secured a handsome office in the Electrical Exchange Building. Mr. Murphy has been in the Exchange Building for some time, but has now been compelled to occupy an entire office to accommodate his increasing trade as well as to make room for some handsome sample slate and marble switchboards, etc., of which he makes a specialty. A feature Mr. Murphy is introducing in his business is the making of drawings of switchboards, etc., and sending them direct to the quarries, where all drilling of holes and cutting is done. This saves time and trouble, making it necessary only to assemble the instruments thereon.

COBB, DANBY & KNOTT.—The firm of Cobb, Danby & Knott, general contracting and supervising electrical engineers, which had its inception a few weeks ago has secured a desirable suite of offices on the first floor of the Electrical Exchange Building. The company is now prepared to make bids in open market on contracts for all classes of electrical equipment. The gentlemen composing the firm have all held responsible positions with the larger electrical companies. They are Eastern agents for the Riker dynamos and motors and Hart switches and specialties manufactured at Hartford, Conn.

MR. E. F. KELLEY AND M. R. RODRIGUES have joined forces and hereafter will be known in a business way as the Premier Electric Co. They are located at 11 Whipple street, Brooklyn, and have facilities for handling everything in light repair work. They are also manufacturing a special type of carbon battery, and the Premier dry battery and fan motors of the same name. The shop will be in charge of Mr. Rodrigues, whose work gives evidence of his being a thorough craftsman. Mr. Kelly will look after the sales and business generally.

MR. JAMES H. MASON, inventor of the well-known Mason battery, has been ill at his home in Brooklyn, N. Y., for something over three weeks, his ailment being pneumonia. His many friends will be glad to know that he will soon be on his feet again, although he is not able to do any work at the present time.

THE C. & C. MOTOR CO. report an unusual demand for motors of large capacity. Several orders for 100 horse-power motors have been received. Their present plant is far too small to cope with their increasing business. Early in the spring a much larger factory will be built just outside New York.

THE NEW YORK INSULATED WIRE CO. are about settled in their new offices. The location is a desirable one, and it is needless to say that at 15 Cortlandt street they are within easy reach of all the electrical interests in the city. They have taken the whole suite across the front of the building on the fourth floor.

THE BLAKENEY ELECTRIC CO., 435 Broadway, Brooklyn, N. Y., is introducing a special, neatly constructed and remarkably efficient induction coil for experimental use. Catalogues giving particulars and prices will be mailed. This company manufactures and deals exclusively in experimental apparatus.

MR. C. W. PRICE, a former resident of this city, and until recently a representative of the Northwest Thomson-Houston Co., of St. Paul, Minn., has resigned his position there and returned to New York, where he intends locating.

MR. E. P. THOMPSON, of Temple Court, reports a large sale of his admirable book: "How to Make Inventions." It is a perfect gold mine for inventors and will probably reach several editions.

GEN. O. E. MADDEN has secured in the Electrical Exchange Building a desirable suite of offices which he is fitting up in handsome shape.

AMSTERDAM, N. Y.—The Amsterdam Street Railway Company, Amsterdam, N. Y., since January 1st have combined the offices of secretary and treasurer with that of general manager. This leaves their able manager, Mr. H. K. McCay, open for position at that time.

MR. W. H. WISSING, who has represented the interests of L. J. Wing & Co. in the West for several years, is spending a few days in this city. The Western office of the firm is located at 96 Lake street, Chicago.

WESTERN NOTES.

THE GREAT WESTERN ELECTRIC SUPPLY COMPANY, Nos. 201 to 207 S. Canal street, report a most gratifying increase in the demand for their electrical goods, especially their Sun arc lamp, which is giving universal satisfaction. It can be used singly or in series and gives a most beautiful, steady, white light. They are also receiving large orders for a new focusing arc lamp, several of which are in use in various parts of the city. There is also an ever-increasing demand for their celebratad K. K. wire. They are doing a large business in housegoods supplies, and the sales are increasing daily. The fixture department reports very large sales in Missouri, Louisiana and Illinois. The business of this year compared with last, shows a big gain, while the outlook for 1892 is better than it was this time last year.

THE ELECTRIC APPLIANCE COMPANY report having closed arrangements for the general selling agency for the Standard lamp. The Standard lamp is a new competiter for favor among lamp users, and from results already secured after prolonged and careful tests it promises fair to be a very strong lamp in the field. The Electric Appliance Company have taken hold of this lamp only after a series of most severe tests, which have proven more than satisfactory. Very strong claims are made for long life, high efficiency and total absence of discoloration, and the lamps which have been burning in the company's stores and offices certainly show up to good advantage, and the indications are that the Electric Appliance Company has added another valuable specialty to their already long list.

"**OLD RELIABLE**" is a fitting name for the Electric Merchandise Company, Chicago. Giving its whole attention to the electric railway supply business and carrying a large stock of such supplies, it has won an enviable reputation for prompt and accurate shipment. Recently improved facilities and an increase in stock make the company more than ever ready to serve the trade in a handsome manner. The company reports this season unusually prosperous. Frequent orders for Brand's steel wire track brooms with Wardwell's patent track broom holders come in, besides large orders for motor parts, station, car and line repairs. An encouraging order just received by this company was for 3,000 pounds of the well known "E. M. Co." tape.

MR. WM. HOOD, 239 La Salle street, has just made up a model private lighting plant consisting of gas engine, dynamo and storage batteries. Everything is exceedingly handsome and complete, and he will no doubt sell a large number of small plants for private lighting as there are many advantages clearly shown in this plant that will be appreciated by those who desire a cleaner and more beautiful light than gas, at a reasonable expense.

THE CENTRAL ELECTRIC CO. have just taken the agency for Illinois, Missouri, Nebraska and Indiana for the Interior Conduit & Insulation Company, and will carry in stock at Chicago, St. Louis, Kansas City and Omaha a sufficient supply to meet the demands of the business. This is a very important agency, and the Central Electric Company can be congratulated in securing it.

THE ELECTRIC MERCHANDISE CO. report numerous orders coming in all the time during the cold weather for extra supplies for Burton electric heaters by those who have used them, and are also placing on their books names of many new customers who are adopting this highly desirable method of heating their cars.

NEW PROCESS WELDING AND SPINNING CO.—The annual meeting of the above company was held at its offices, 21 Rialto Building, Chicago, January 5, when the following officers were elected for the ensuing year: Geo. D. Cook, president; Mortimer McRoberts, vice-president, and W. L. Trowbridge, secretary.

THE CENTRAL ELECTRIC CO. report a very flattering increase in their lamp orders, and the immense stock of various voltages and sizes which they carry enables them to make exceedingly prompt shipments, which are being thoroughly appreciated by users of incandescent lamps.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

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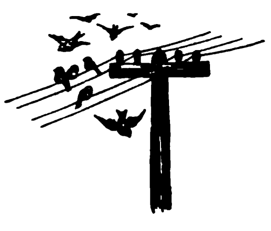
THE NEW EQUIPMENT OF THE WESTERN UNION TELEGRAPH COMPANY'S OFFICE IN NEW YORK.

BY

Alfred S. Brown

Electrical Engineer, Western Union Telegraph Company.

I.



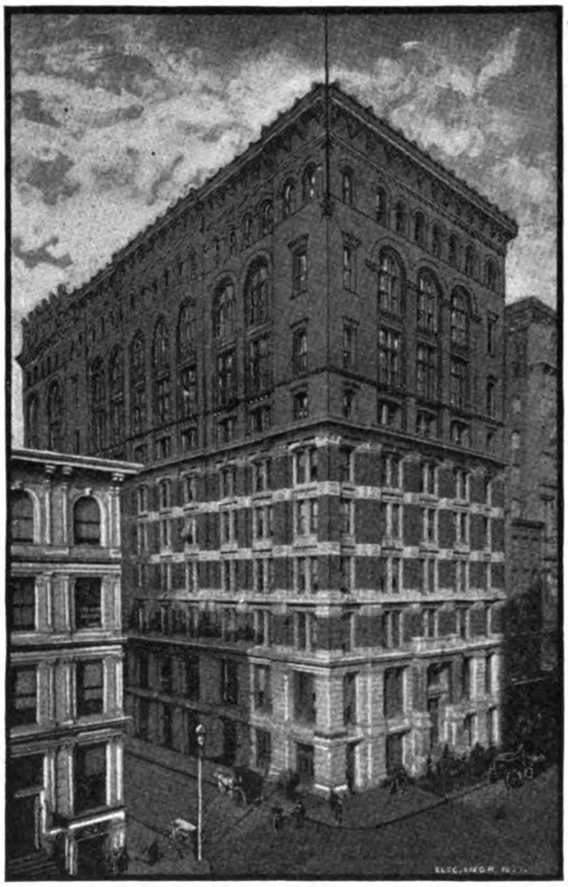
THE new general office of the Western Union Telegraph Company, in New York, is, with one exception, the largest telegraph office in the world. In respect of volume of business handled, it is second only to the London office and a very good second at that. In completeness of equipment and adaptation to all possible requirements of the modern telegraph service it easily takes first rank. It is intended to point out, in the following, some of the characteristics which distinguish this from all other telegraph offices and which are relied upon to establish the claim that it is the best-equipped telegraph office in the world.

The building in which the office is situated was designed and built to meet the peculiar requirements of the telegraph service. It is thoroughly fireproof in construction and every precaution has been taken in fitting it for use to prevent the possibility of a recurrence of such a disaster as destroyed the old office on July 18, 1890.

Two thousand one hundred and fifty wires enter the building from underground conduits. These wires are led in cables of one hundred conductors through iron ducts to a terminal board enclosed in a fireproof vault under the Dey street front. This terminal board is of slate supported in an iron frame and is fitted to receive 3,200 wires. Leaving this vault the cables enter wrought-iron pipes three inches in diameter, a separate pipe being provided for each cable, and are led through two widely separated fireproof shafts, indicated in Fig. 1, to the operating department on the seventh and eighth floors. On reaching these floors the cables, leave the pipes and enter ducts formed in the floors through which they are distributed to the various switches.

The construction of the floors and floor-ducts needs a brief description. The iron floor beams and brick arches are of the usual kind. On these was placed a network of wooden forms or moulds to shape channels from four to six inches deep and twelve inches wide. The spaces intervening between the forms were filled in with concrete, after which the forms were removed and a coating of rock asphalt an inch in thickness was laid on the bottoms and sides of the channels. Over the channels were then laid slabs of slate, thirteen inches wide and one inch thick. The floor between these slabs was then covered with one inch of rock asphalt, which makes the surface of the finished floor. The slate slabs are in short lengths and may be readily lifted out of place, giving convenient access to the wires in the channels.

The finished ducts are three to five inches deep and ten inches wide. They run in parallel lines, crossing each other at right angles at a distance of about eight feet apart, and are so planned as to bring the intersections under the centres of the operators' tables. At each intersection an iron plate 13 inches square takes the place of the slate slab for convenience in reaching the wires without removing the slate. Wires from the floor to the tables lead up up through iron ring frames set in the floor directly under the centre of each "quartet" table and split cast-iron pipes protect the wires between the tables and the floor. The floor channels are filled at intervals of a few feet with sea beach sand as a security against the spread of fire in them.



THE WESTERN UNION TELEGRAPH BUILDING, NEW YORK.

The cables and all of the insulated wire used in the building are covered with fireproof braid outside of the insulating Kerite or "Safety Insulated" compound.

The wire used is of Nos. 16 and 18 B. W. G., insulated to $\frac{6}{32}$ and $\frac{5}{32}$ inches, respectively, exclusive of the braid. Every joint in the office is thoroughly soldered and insulated with as much care as is given to cable jointing. In fact this part of the work was done by a detail from the company's cable crew.

II.

It has been the common practice in telegraph offices to lead all wires to one central point where the switch is located, the point selected being usually, for convenience, directly over the flues or wire-ways leading from above or below. Such an arrangement is plainly objectionable as exposing the most vulnerable point in the office to the greatest danger from fire. In this case, instead of the usual central switch there are five main line switches separated as widely as possible from each other and placed as far as possible from elevator shafts and stairways. The location of these main line switches is shown in the floor plan, Fig. 1.

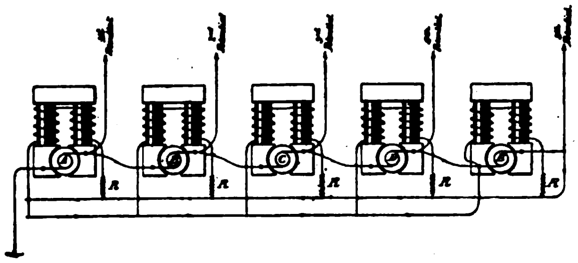


FIG. 5A.—ARRANGEMENT OF TELEGRAPH DYNAMO PLANT.

This method, besides affording greater security from fire, permits each section of the switch to be located in that division of the office where its wires are operated, a feature which becomes of great importance in large offices. For convenience of commumication between the chief operators of the different switches, an office wire is provided connecting all switches and furnished with keys and sounders at convenient intervals on the switch tables.

The five main line switches are of the usual double-jack pattern with a total of ten hundred and twenty-five straps and thirty horizontal rows of discs. They are supported in iron frames with clear glass panels at the ends and front, and are surmounted by frames containing banks of lamps used as resistances, as illustrated in Fig. 2, which shows the "City Lines" switch. About twenty-one hundred of these lamps are in use over the switches, as will be explained later. Behind each main line switch is placed a set of knife switches which, when opened, cut off all dynamo leads and ground connections from the switch. This is only useful as a precaution against fire.

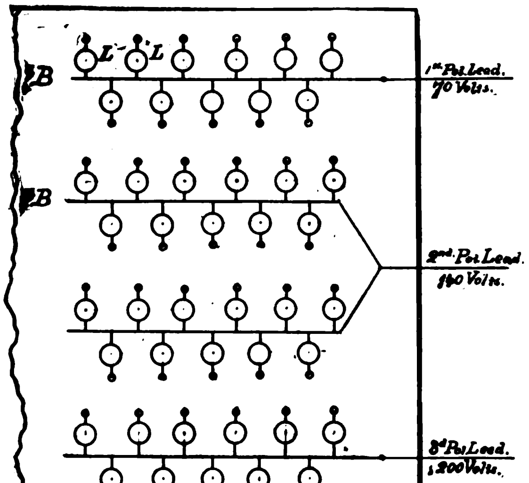


FIG 6.—ARRANGEMENT OF RESISTANCE LAMPS ON SWITCHBOARDS.

The main lines from the street are connected to the switch through "W. B. G" protectors. These protectors consist of a short piece of fuse wire (No. 20) around one end of which is wound a number of turns of No. 30 silk-covered German silver wire. The heating effect of any abnormal current is relied upon to melt the fuse wire. This device is capable of accurate adjustment so as to open the circuit on any desired current with great certainty. In this case the maximum current that the protectors will carry is ¾ ampere. They are placed directly back of the switches. Loops and instrument wires with their cords

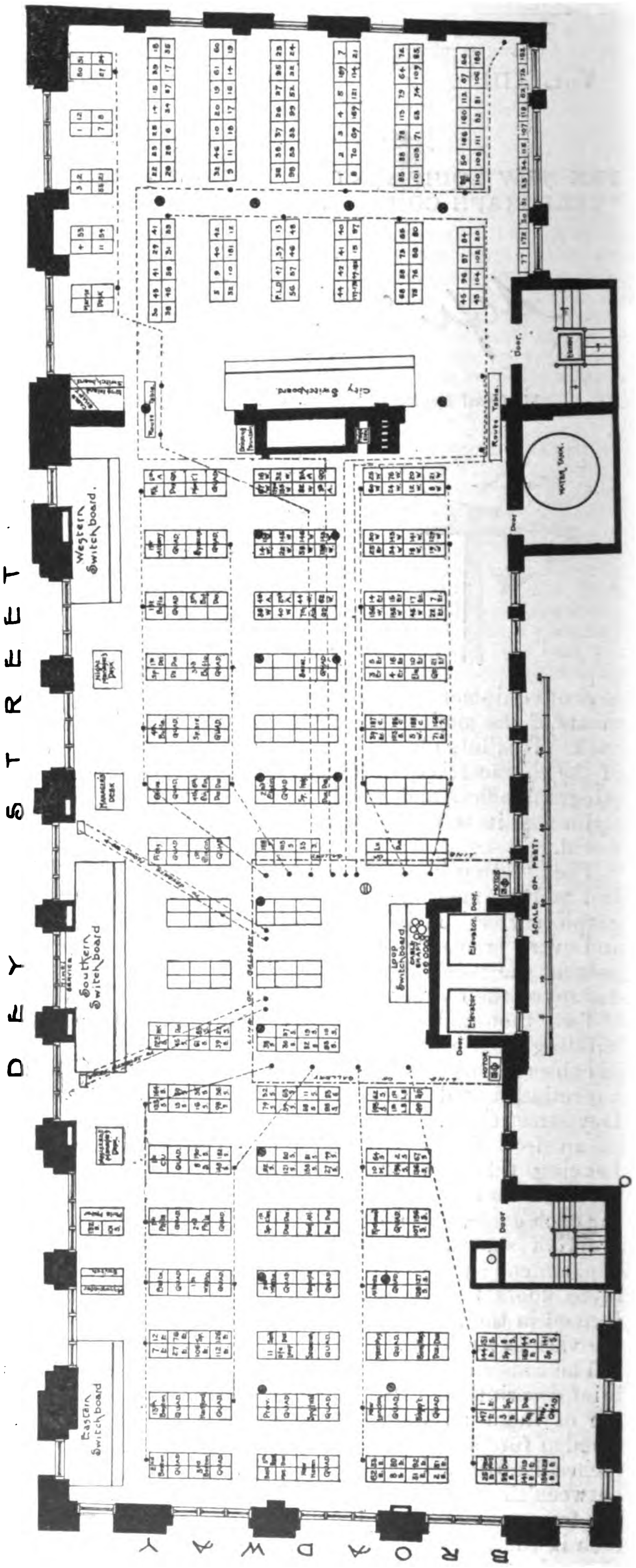


FIG. 1.—PLAN OF GENERAL OPERATING ROOM, 8TH FLOOR.

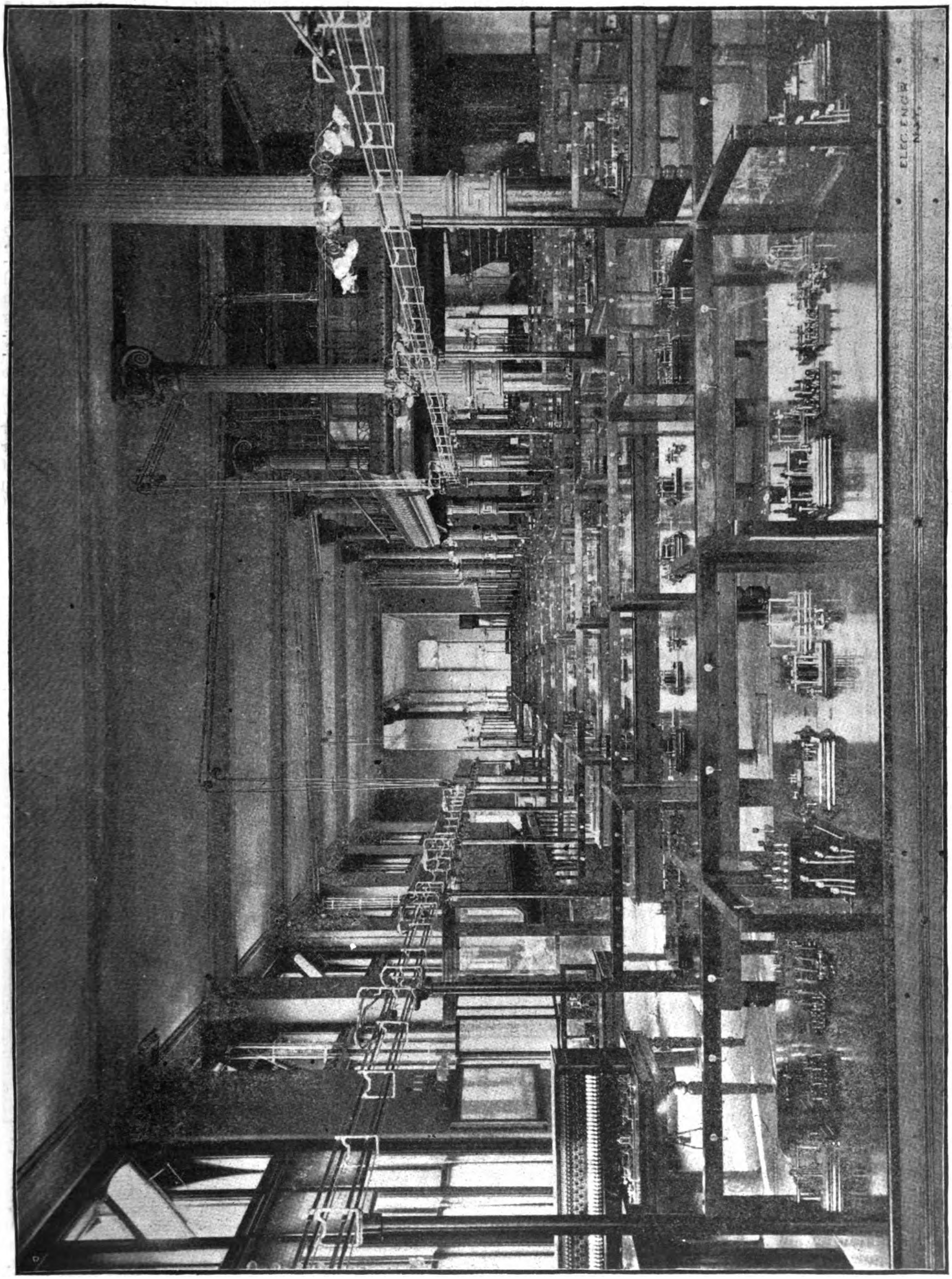


FIG. 10.—THE NEW EQUIPMENT OF THE WESTERN UNION TELEGRAPH CO., NEW YORK.—GENERAL OPERATING ROOM, 8TH FLOOR.

connect with terminal boards, also back of the switches, in the usual way.

In addition to the five main line switches above mentioned there are a number of others used for special purposes. The most important of these is the "Loop Switch," Fig. 3, which is a collection of 375 spring jacks with 450 cords and wedges. The frame supporting this switch carries in the lower part a board with 900 lamp sockets fitted to receive resistance lamps, two for each loop. Every quad and duplex loop entering the office is led directly to this board and connected through a pair of lamps to a double conductor cord terminating in a wedge. The jacks connect with the quad and duplex sets of repeaters, etc., in different parts of the office. Thus any loop may be connected to any multiplex set by inserting the wedge in the proper jack. The lamps have resistances ranging from 20 to 80 ohms and serve to equalize the resistances of the loops, bringing all to a standard of 92 ohms in each "leg" or as nearly as practicable thereto. Nine hundred lamps are required to equip this switch.

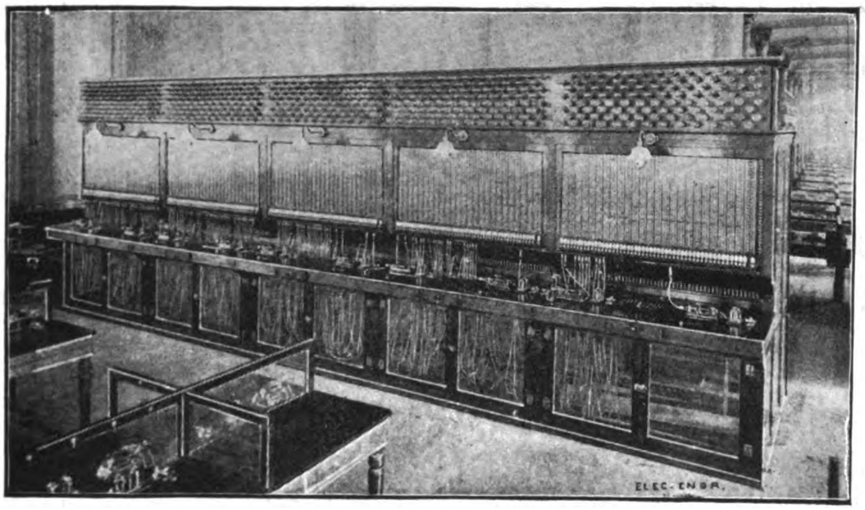


Fig. 2.—The "City Lines" Switchboard.

There are 125 "flying loops," so called, connecting this switch with all other switches, by means of which any wire from any of the other switches may be brought to this switch and thence to any part of the operating rooms. A number of special dynamos used as intermediate batteries are brought in here and may be thrown by means of these "flying loops" into any of the main line switches, as required. The functions of this switch are not unlike those of the central office in a telephone exchange system. This loop switch and the system of operating the multiplex loops connecting with it is due to the skill and ingenuity of Mr. George W. Gardanier, who has succeeded in providing for about every conceivable requirement, or emergency.

Another valuable device is the annunciator switch, Fig. 4, page 82. This consists of 100 annunciator drops set in a frame with an equal number of spring-jacks connected with an automatic alarm in the usual way. The magnets operating the drops are of low resistance, that is, about two ohms. Each magnet is assigned to, and kept in circuit in, one of the leased wires and is between the loop running to the lessee's office and the dynamo. Its purpose is to enable the lessee's operator, without any delay, to call the attention of the chief operator in the general office to any interruption on the wire. To do this the lessee's operator "grounds" for an instant the wire in his office by touching a button. This, of course, throws through the annunciator magnet a current strong enough to operate the drop and ring a signal bell. The operator in charge at once connects into the circuit through the spring-jack and without loss of time is in communication with the lessee's office. This device is the invention of Mr. James B. Hurd and is a valuable addition to the office equipment.

Another piece of apparatus which has an important function to perform is the "time repeater." At noon every week day a signal is received from the U. S. Naval Observatory, at Washington, which indicates the exact hour. This signal is sent out from New York in all directions, at the present time on sixty different lines. The "time repeater" consists of ninety-two repeating magnets operated by local current through the points of a relay in the Washington circuit. The repeating points of the ninety-two magnets connect by as many loops to the five main-line switches where they are connected to the lines over which the time signal is to be sent. This apparatus can also be used as a repeater for sending dispatches over a number of wires at one operation. For example, election returns, bulletins of which have to be sent out on election night in every direction, may now be sent on nearly a hundred lines by one operator.

A good idea of the general arrangement of the operating room on the eighth floor will be gained from the engraving, Fig. 10, page 80.

The seventh floor contains the Wheatstone instruments, the automatic repeaters (Milliken-Hicks pattern), the quadruplex apparatus instruments used on such lines as are operated by branch offices direct and not requiring operators at the central office, the Gold and Stock quotation service, the commercial news department, etc. The latter have switchboards devoted specially to this service. About thirty perforating machines are required for preparing messages for transmission by the Wheatstone instruments, and as many typewriters copy the received slips for delivery. Four Wheatstone circuits are in operation, two to Chicago, one each to St. Louis and New Orleans. On the Chicago circuits a speed of 175 words per minute is easily attained with one repeater in circuit at Buffalo.

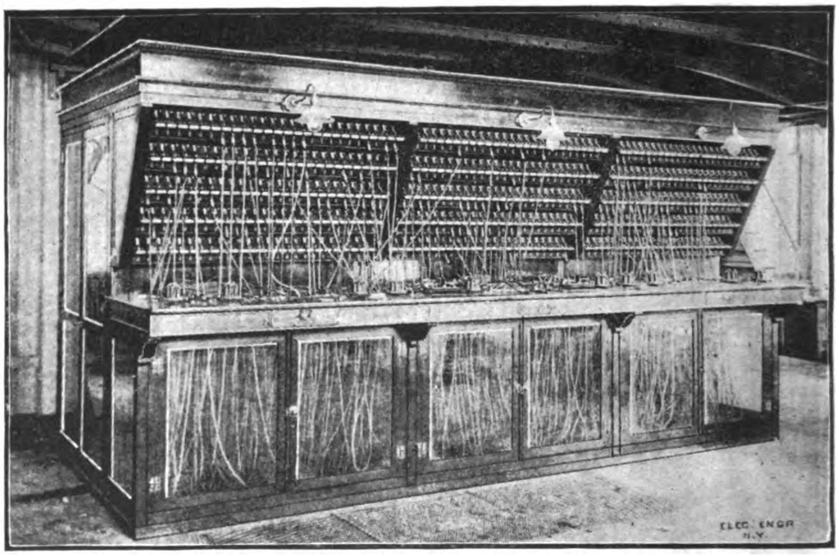


Fig. 3.—The Loop Switch Under Distributing Gallery.

Of the automatic repeaters there are fourteen in readiness for use. New York being the natural terminus of all circuit, a large number of repeaters is not required. They are all connected with the loop switch through which they can be connected with any lines entering the office.

The quadruplex sets on this floor are thirty in number and as they are operated by branch offices only, are compactly placed, a complete set (four "sides") on one desk.

There are five transmitting machines on the seventh floor for sending out quotations to as many classes of tickers, viz., produce, cotton, petroleum, coffee and financial news. The transmitters are each operated by small electric motors.

III.

In the cellar under the Broadway end of the building are the dynamos which supply the currents for telegraph work. The first dynamos ever used as substitutes for chemical batteries to furnish currents for telegraph purposes were placed in the New York office by Mr. Stephen D. Field, in 1880. Previous to their introduction, about 20,000 cells of "gravity" battery were used in the office.

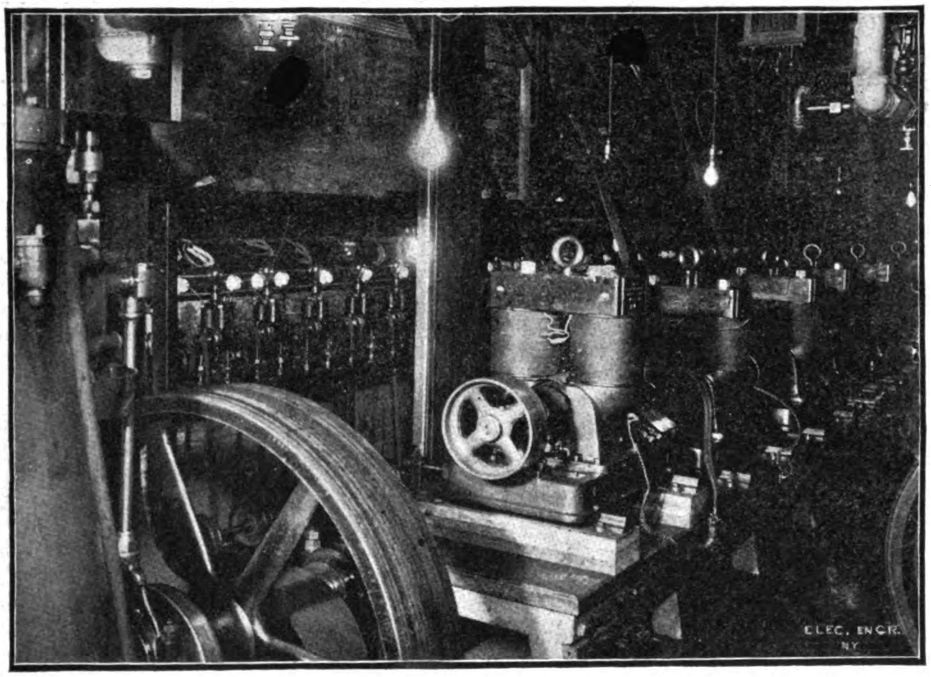


FIG. 5.—ONE SECTION OF DYNAMO TELEGRAPH PLANT, WESTERN UNION BUILDING, N. Y.
(*Taken by flash light.*)

The original dynamos replaced all but about eight thousand cells, that number being retained for locals, intermediate mains, etc. At the date of the fire in 1890 the office contained about 10,000 cells, nearly the whole of the sixth floor of the old building being occupied by the cells The great superiority of the dynamos over the batteries in efficiency of service, low cost of maintenance and saving of room had been abundantly demonstrated, and it was determined that in the reconstructed office dynamo currents should replace all others. So thoroughly has this plan been carried out that not a single cell of battery now remains in the building.

There are three gangs of dynamos supplying main-line currents, each gang consisting of five Edison 40-ampere machines connected in series and a view of which is given in Fig. 5. The first and second of each series have a potential difference of 70 volts each, and the third, fourth and fifth, 60 volts each. Leads from each machine carry currents of 70, 140, 200, 260 and 320 volts to resistance lamps in the operating department. The three lower potentials, only, are carried to the switches, the 260 and 320 volt leads being used exclusively for duplex and quadruplex circuits which take their currents through a separate bank of lamps. One gang of dynamos furnishes positive, and one negative currents. The third is a spare or relief gang and is so connected through a reversing switch in the dynamo-room that it may supply currents of either polarity, as required, to relieve either of the others. There are also two 80-ampere machines supplying currents at 23 volts for loops; two 300-ampere machines supplying currents at 7 volts for locals, and two 40-ampere machines supplying currents at 45 volts for city and short-line service. Of these lower-voltage machines only one of each pair is in use at one time, the other being held in reserve. Each gang is driven by a separate vertical engine of 16 h. p., running at 160 revolutions. The dynamos all run at 1,250 revolutions, belting from overhead shafting. The fields of all the machines in each gang are in multiple and are excited by a 60-volt current from the fifth machine of the series, as shown in Fig. 5A, page 78, this machine having less work to do than either of the others.

The dynamo switchboard contains indicators connected with the 4th potential, positive and negative leads, also for the three 5th potential machines and for the low-voltage machines, as well as regulators for each of the three 5th potential and for the six local loop and city dynamos. Regulators for all the others are placed directly over their respective machines.

There are in this room, in addition, 30 small dynamos ranged along the wall, as seen in Fig. 5, and used as intermediate main-line batteries. These deliver currents at from 50 to 125 volts, each machine having attached to it a one-half ampere lamp connected permanently in the circuit. As each feeds one wire only, they normally supply currents of .03 or .04 ampere.

The 1st, 2nd and 3d potential leads from the dynamos terminate in the operating-room in bus-bars placed directly over the switches, Fig. 6, page 78, in which B B are bus-bars and L L lamps. The lamps are held in sockets, one terminal of each connecting with its bus-bar and the other (through a short wire on the back of the board, not shown in the figure), with a disc in the switch directly beneath. Each lamp connects with one disc only. One horizontal row of discs is assigned to the first potential lamps, two rows to the second and one to the third. As comparatively few wires are worked on the 1st and 3d potentials and many on the 2nd, the latter has two rows of discs assigned to it, so as to avoid having to feed two wires through one lamp, which is objectionable for the same reasons that make it objectionable to work two wires from one battery.

The lamps used are specially designed for the purpose. The 1st potential lamps have one filament measuring (cold) 140 ohms; the 2nd have two in series measuring 280 ohms, and the 3d three in series measuring 400 ohms. On short circuit, with the currents supplied from the dynamos, these lamps all carry six-tenths ampere, showing with that current a dull red glow. This serves a valuable purpose as a signal calling attention to ground connections on the lines. Whenever a lamp is seen to glow, the chief operator knows at once that the line connected to the disc and strap directly below is grounded, without waiting for a report from the operator.

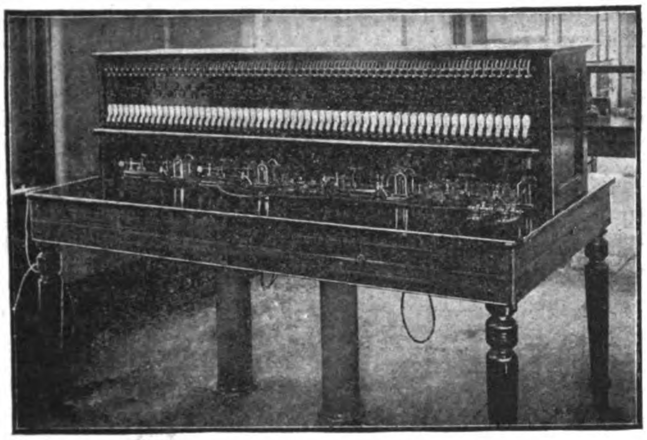


FIG. 4.—THE ANNUNCIATOR SWITCH FOR LEASED LINES.

It is to be noted that dynamo leads of only one polarity are connected with any one switch. The Eastern switch 200 lines, Long Island switch 75 lines, and the City switch 250 lines, are supplied with positive currents only, and the Southern switch 300 lines, and Western switch 200 lines, with negative currents only.

The local (7 volt) dynamos supply currents for operating all Morse and repeater sounders, the former being wound to 100 ohms. The repeater sounders, requiring extremely prompt action, are wound to 20 ohms and a non-inductive resistance of 20 ohms is placed in circuit with each. The multiplex loops are operated with the current of 23 volts, the resistance of each leg of each loop being adjusted to about 92 ohms. The loop magnets are wound to four ohms and the transmitter magnets each to six ohms. A considerable number of branch offices, as many in some cases as ten, are connected on one loop.

IV.

In a large telegraph office one of the first essentials to the proper handling of business is a means of rapid and continuous communication between all its parts. The London office depends upon pneumatic tubes for this purpose. In the New York office the requirements have been very successfully met by means of a cable carrier system. On the 8th floor, a plan of which is shown in Fig. 1, in the centre of the room, is a gallery 35 by 20 feet from which radiate 16 lines of message carrier railways each being a double-track line wtih four to six stations. The engraving Fig. 7, will give a good idea of the arrangement for the delivery and distribution of messages.

The system employed is an adaptation of the "Martin cash carrier" system and consists essentially of a number of double-track miniature cable railways radiating from the central station on the gallery. The carriers are so constructed that they drop the driving cable and are automatically "side tracked" at the particular station on the floor for which they are intended. There are at present 57 stations on the two floors, the location of those on the 8th floor being shown in Fig. 1. Two 5 h. p. Crocker-Wheeler motors furnish the power for running this system, one only being in use, while the other is held in reserve. Fig. 8 shows one of these motors driving a shaft under the gallery. The speed of the carriers is about 750 feet per minute and as the longest line is not more than 125 feet in length the most distant station is reached in ten seconds.

The gallery also contains the terminal valves of 24 pneumatic house tubes communicating with the receiving and delivery departments, the executive floor and other departments. Four pneumatic tubes to Twenty-third street and intermediate offices and four to the exchanges below Wall street are also operated from this gallery. Thus all messages coming into, and going out of, the general operating department must pass through this central distributing point.

V.

The pneumatic system is quite extensive. Four tubes of 3 inches internal diameter extend from Dey street through Broadway, Fourteenth street and Fifth avenue to the company's building at the corner of Twenty-third street. Two of these tubes, one for up and one for down business, have way-stations at Nos. 407, 549 and 854 Broadway; the other two run through to Twenty-third street direct. The tubes are of brass, weighing three pounds per foot. They are in 20-foot lengths with accurately fitted flanged couplings at each joint. They are laid in boxes of creosoted 2-inch spruce plank about three feet below the surface and near the middle of the street. Manholes three feet square are placed at intervals of 400 to 450 feet and in every alternate manhole expansion joints are provided. Two 2¼ inch tubes of similar construction extend from Dey street through Broadway, Maiden Lane and Pearl street to the company's office 134 Pearl and the Cotton Exchange, and two others through Broadway, Wall and Broad streets to the company's building, No. 16 Broad street and the Stock Exchange, with a way station in the Equitable Building. Six other single lines of tube 1⅝ inch in diameter extend through Broadway and Park Row to the offices of the daily morning papers. There is altogether a total length of 70,320 feet (over 13 miles) of underground tube in operation.

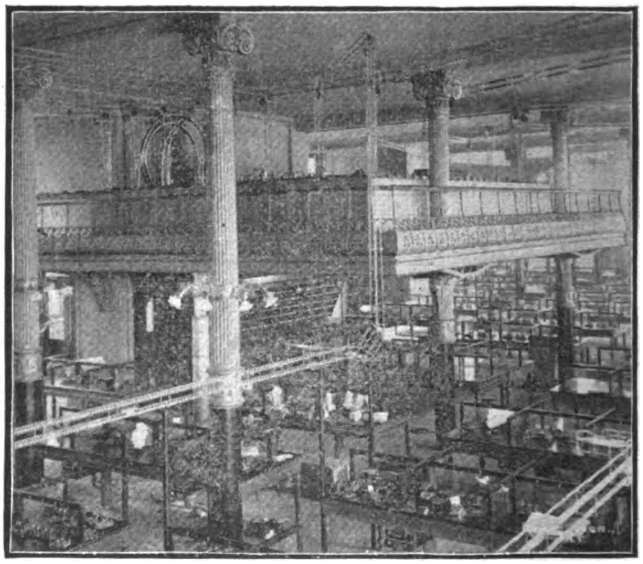


FIG. 7.—THE "MARTIN" CABLE CARRIER DISTRIBUTING SYSTEM.

The tubes running to Twenty-third street are operated by vacuum alone, power being provided at both ends of the line. The speed attained on these tubes is about 24 miles an hour with the gauge showing 22 inches, which is the usual working vacuum. With both pressure and vacuum, carriers have made the distance between the general office and Twenty-third street (13,454 feet) in 2 min. 38 secs.; but a pressure of 22 pounds in addition to 20 in. of vacuum was required to accomplish this. The shorter tubes are operated by pressure for outgoing and vacuum for incoming carriers, 7 pounds pressure and 15 inches vacuum being the usual standard. All lines are double, that is, one tube for up and one tube for down business, except those to the newspaper offices. The latter are therefore provided with signal wires. But in all cases the double-line tubes are operated without signals, carriers following each other as fast as occasion may require. The capacity of the tubes is therefore far greater than where a block signal system is used, as is always done in Europe, and no inconvenience has been found to arise from the practice followed here.

The cellar under the Western Union Building contains the engines and air pumps which operate the tubes. These consist of two horizontal direct-acting adjustable cut-off duplex engines and air pumps, shown in Fig. 9. The steam cylinders are 20 in. and the air cylinders 32 in. in diameter and 36 in. stroke. With 80 pounds steam pressure the engines are capable of developing 125 h. p. for each cylinder, that is, a total of 500 h. p., but nothing like this amount of power is required for ordinary operations. As now working they develop about 40 h. p. Each engine has a fly-wheel 14 feet in diameter, weighing seven tons. Pressure and vacuum tanks are provided of suitable capacity to secure easy and regular working. The whole plant is duplicated at the Twenty-third street building.

At times there is more or less water in the tubes due to condensation; this makes necessary the use of carriers which will protect their contents from dampness. The carriers are of a rubber compound in the form of a tube slightly smaller in diameter than the pneumatic tube and about seven inches long, the bottom being closed with a flange fitting easily the tube and the top covered by a flanged cap screwed on the carrier. These carriers are a trifle heavy but are strong and durable as well as waterproof.

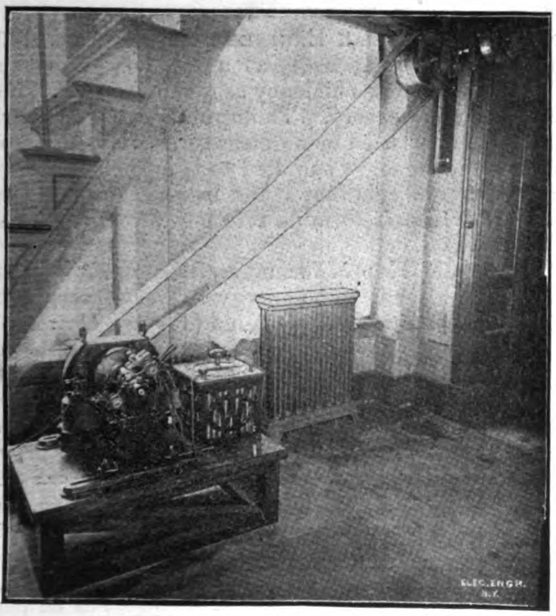


FIG. 8.—CROCKER-WHEELER MOTOR FOR DRIVING CABLE CARRIER SYSTEM.

VI.

The building is lighted throughout by electricity, the current for the purpose being supplied by three Edison No. 16 (45 K. W.) machines, driven by three 75 h. p. "Straight-Line" engines. These are situated in a room adjoining the telegraph dynamo-room. Steam is supplied from the street mains, but for security against accidental interruptions to this supply there are in the building six boilers always kept ready to fire up at a moment's notice.

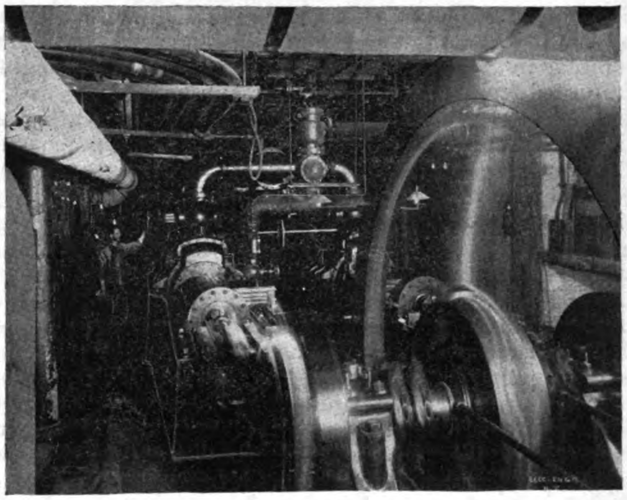


FIG. 9.—ENGINES AND AIR PUMPS OF THE PNEUMATIC TUBE SYSTEM.—(*Taken by flash light.*)

The building as a whole, or at least the reconstructed part, which comprises all above the fifth story, is in marked contrast to the old building, which was regarded at the time of its completion, just seventeen years ago, as a model telegraph building. But the enormous growth of the telegraph business had made the old quarters quite inadequate long before the fire occurred which necessitated the reconstruction, and the company acted wisely in placing in the hands of General Eckert, its vice-president and general manager, full power to construct such a building as would meet the wants of the present and as much of the future as it is possible to foresee. Under his supervision, not only the requirements of the operating department, but also of all the executive departments of the company have been carefully and amply provided for.

Some statistics of interest as showing the magnitude of the business here transacted may be of interest. About 750 lines radiate from the building, by far the larger number being operated by the familiar Morse system. There are four lines operated by Wheatstone, forty-two duplex and sixty-two quadruplex lines. Two lines are operated by "combination" printing instruments. The office is provided with fourteen automatic repeaters, and has accommodations altogether for about eight hundred operators. The longest circuit is from New York to San Francisco, about 3,400 miles. The volume of business varies slightly at different seasons, but the daily average for the year is over 100,000 messages, exclusive of press reports.

WORKS ON THE TELEPHONE.

MESSRS. WHITTAKER & Co., of London, have made arrangements with the editor of *El Telegrafista Espanol* for the translation into Spanish of Mr. Preece's work upon "The Telephone." The book already has been translated into both French and German. The same firm will publish shortly, in a cheap form, Mr. A. R. Bennett's papers on the "Telephoning of Great Cities" and the "Electrical Parcel Exchange System," which attracted considerable attention at last year's British Association meeting.

THE WESTERN UNION'S NEW OFFICES.

The contribution of Mr. Alfred S. Brown, the electrical engineer of the Western Union Telegraph Co., which will be found elsewhere in this issue will give an excellent idea of the electrical and mechanical equipment of the new offices of the Western Union Co. in New York ; but our readers may also be interested in a few details relating to the general equipment.

On the seventh and eighth floors is the general operating department. The dimensions of each of these floors are 75 by 200 feet, having windows on all sides, 36 on each floor, ranging in width from 5 to 14 feet. At night light is furnished from 600 incandescent lamps. At the east, or Broadway end of the seventh floor is the Superintendent's Office ; at the west end is the book-keeping department. Between them is the Commercial News department, which collects and distributes the quotation service. These consist of stock, grain, oil, cotton, coffee, financial and general news tickers, besides Morse wires connecting with all the exchanges and all the principal cities of the country. On this floor, also, enter the wires leased to brokers, newspapers, etc., and the Wheatstone automatic system. Thirty or more "punchers," as the demands of the service require, prepare the messages for transmission by this system and as many typewriters copy the messages from the slips as they roll out from the receiving instruments. Next to the Wheatstone service and near to the book-keeping department where the files of messages are kept are the assorters, inspectors and service clerks, the first keeping the business of the office arranged in alphabetical order of place of destination, the second noting that every message bears proper indication of transmission and the service clerks making, or attending to, any necessary inquiries.

On the eighth floor are the wires to the Southern, Eastern and Western points, also the City, Long Island, and Suburban wires. On this floor there are accommodations for upwards of 1,000 operators and other employees. Here are the simplex, Morse, duplex, quadruplex Phelps, motor-printer, and marine circuits,—the latter to Quarantine, Highlands, Sandy Hook, City Island, Fire Island ; also the special circuits for the transmission and reception of United States Government weather signals. Over the Marine Circuits are received the reports of all incoming steamers and other vessels.

On the gallery in the centre and on the north side of the room the entire business of the two floors is handled by an efficient corps of assorters and distributing clerks. The pneumatic tubes are on this gallery in connection with the receiving and delivery department on the basement floor, and with the several offices and floors of the building ; also with down-town exchanges, and with the 23d Street Western Union Building, and intermediate uptown offices. The pneumatic tubes to the newspaper offices are worked from the delivery department on the basement floor. There are also on this gallery two revolving belts to facilitate the passage of business to and from the pneumatic tubes and carriers.

Thirty-six cables, containing conductors, enter the building underground to the test board in the cellar. On the seventh floor there are four switchboards and on the eighth six, manufactured by the Western Electric Co., who also furnished the complete equipment of sounders, relays, repeaters and accessory apparatus for the new offices throughout. The total number of flexible switchcords in connection with the various switchboards is about 2,000. Current for the wires is generated by 41 dynamos in the cellar, the larger machines of the Edison type and the smaller made by the C. & C. Electric Company.

Of the 200 miles of insulated wire employed in effecting the various office connections, part consists of Kerite, furnished by A. G. Day, and part of wire of the Safety Insulated Wire Co., of New York.

Wardrobe facilities and the lunch room are on the ninth floor. Here lunch is served to employees between 11.30 A. M. and 3 P. M., and again from 7 to 9 P. M. The kitchen is on the tenth floor and is supplied with all the latest improvements in the culinary art. About one-third of the 1,200 employees of the operating department are women.

On the other general circuits are transmitted and received business to and from all points in the United States and Canada land-line circuits in connection with the European, Bermuda, Nassau, Cuba, West Indies and South America cable stations; all being worked from this floor jointly, or separately, with the service at the Central Cable Office, No. 16 Broad street, from which latter office there are also worked by the recorder system the two ocean cables to Europe. These cables and land lines are also connected into the office at the Stock Exchange, and in addition thereto direct wires from all cable centres of the country are connected at and worked from the "Central Cable" and "Stock Exchange" offices. In connection with the cable service it is interesting to note that the direct wire from the central cable office to San Francisco—the longest in the world—is 3,348 miles in length, and that the next longest is that to Galveston, 1,820 miles. These circuits are worked duplex.

Messages between the seventh and eighth floors and from any section of one floor to another section of the same floor and the same with regard to any section on the other floor are handled by the Martin cable carrier system, there being 57 stations. This system is a modification of the Martin cash carrier system and was installed by the Martin Cash Carrier Co., of Springfield, Mass. The architect of the new building was Henry J. Hardenbergh, of New York.

THE EXPRESSION FOR THE WORK DONE BY MOTORS.

BY

Samuel Sheldon

In The Electrical Engineer for Jan. 20, 1892, Mr. Arner indicates that he is at a loss how to reconcile the formulæ for motor efficiency as given by S. P. Thompson and Kapp, respectively. Thompson's formula refers to a motor, which, if used as a generator, would transform all the mechanical energy supplied to it into electrical energy. Thompson states this fact at the beginning of his chapter on motors. Kapp's formula refers to a real motor, such as we buy.

To reconcile Kapp's formula with Joule's law, take the first case tabulated. The energy fed each second to the motor $= E\,C = 4{,}500$. Of this $(E - e)\,C = 405$ watts is dissipated in heat. There is a further loss because of friction, etc. Its amount can be determined from the results of the experiment cited, where four amperes were required to run the motor when unloaded. In this experiment the energy given each second to the motor was 400 watts. The loss from heat $C^2\,R = 16 \times 0.2 = 3.2$. The difference, 396.8, is required to overcome friction, etc.

We have, therefore, in (1) : Loss from heat, 405 ; loss from friction, etc., 396.8.

$$\text{Efficiency} = \frac{\text{Useful energy,}}{\text{Energy supplied,}} = \frac{3698.2}{4500} = 82 \text{ per cent.}$$

For (2) : Loss from heat, 80 ; loss from friction, 396.8.

$$\text{Efficiency} = \frac{\text{Useful energy,}}{\text{Energy supplied,}} = \frac{1523.2}{2000.0} = 76 \text{ per cent.}$$

For (3) : Loss from heat, 1125; loss from friction, 396.8.

$$\text{Efficiency} = \frac{\text{Useful energy,}}{\text{Energy supplied,}} = \frac{5978.2}{7500.0} = 80 \text{ per cent.}$$

THE CARE OF RAILWAY MOTORS.

BY

Lucius E. Marple.

Queerly managed roads are sometimes to be found in out-of-the-way towns. The dynamo tender at the light and power plant dispenses all the electrical knowledge to be had, while the superintendent is perhaps busy performing the additional office of treasurer. All the electrical instructions that were given on the founding of the road have been handed along in tradition by the motor-men, undergoing curious modifications meantime.

In many larger towns as well, it is likewise the fact that the men are ill-instructed how to handle their cars. Scarcely any piece of machinery is more simple and economical than an electric motor, yet even it has its limits of endurance—it is costly apparatus and should be treated with care. Skilled men are not needed to operate it, but the rules of its makers should be observed to some extent. An eminent engineer recently remarked that the success of any electric road was in the hands of the armature-winders and motor-men.

The managers of several enterprising roads keep a reading-room of electrical books and papers for their men, and in addition to this it is found profitable to give them talks on the management of their cars.

Of course the first requirement of a motor-man is caution added to common sense. He should be required to examine his motors near the end of every trip, and if a little informed, he may save his company many dollars in the course of the year by fixing on the spot, either temporarily or otherwise, any small trouble that may occur, such for instance, as loose connections, broken brush-springs, and the like.

Almost every system has its own way of controlling the current, but a few points may be mentioned in general which are common to all systems. How to hurry a car is an art that but few motor-men attain properly. The current should not be thrown half on instantly. Let the car start very easily, and when a little motion has been gained it can be applied much faster. On the other hand, if time is to spare, do not drag the car along on the first points of the switch. It requires much less power and is easier on the armatures to run at a higher speed, and then to coast when opportunities are given. Get all the power on as soon as practicable in going up a hill (excepting some systems where the last point on the switch or the "loop" is only to be used for speed on nearly level ground).

It is not economy to ascend a steep hill or to run any length of time with only half the power on.

The delight of a new motor-man is to try the reversing effect on his car, and this of course is of no material benefit to it either. When for some reason the car does not start as soon as the current is applied, do not throw it all on immediately. If half of the current will not start the car, stop and investigate the cause. It is harmless even to caution motor-men not to leave the switch partly on in such an event. I remember to have seen such a case, where the motor-man found at length the trolley was off, and on replacing it was rather startled to see his car sail off and leave him.

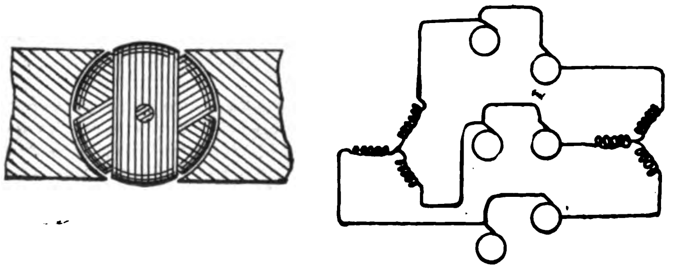
The vital parts of the motor are the commutator and its fittings. It should be constantly examined for surface irregularities, which work ruin to both it and the brushes, and consequently the motor. This in many cases is the primary cause of burnt-up brush springs.

It should be the chief feature of the work of night cleaners to see that every part of the commutator and its fittings is thoroughly clean and firm, and the insulation about the edges of the commutator in perfect condition. Loose pinions also should be renewed at once. It is a particular case where a stitch in time saves nine.

Perhaps some of these rules may seem scarcely worthy of mention, but electricians will agree with me that there are plenty of instances where they may all be used to advantage.

THE INVENTOR OF THE THREE-PHASE ALTERNATING MOTOR SYSTEM.

In a communication which appeared in one of our contemporaries a short while ago, Mr. C. E. L. Brown, the well known Swiss electrical engineer, in referring to the transmission of power between Lauffen and Frankfort, sought to correct the erroneous impression that the three-phase system was the salient feature of this installation, and pointed out that the principal object of the experiment was to prove the possibility of producing and transmitting high-tension currents over long distances by naked wires suspended from poles, and with such a degree of security against danger and such a small amount by leakage as to demonstrate that this method has a right to commercial existence. The adoption of the three-phase current, according to Mr. Brown, only increased the difficulties to be met since nearly all the apparatus thereby became more complicated, and the only reason justifying the adoption of the three-phase current was to demonstrate its advantages when applied to several small motors at the same time. The only novelty in the system shown at Frankfort were important constructive improvements in its application which Mr. Brown, almost without exception, claimed as his own. Mr. Brown concluded by asserting that the three-phase current as applied at Frankfort was "due to the labors of Mr. Tesla, and will be found clearly specified in his patents."



Drawings in Tesla's Patents.

In reply to the above, Mr. Carl Hering thought that Mr. Brown had not done proper justice to the real inventor of this modification of the Ferraris-Tesla system, namely, Dobrowolsky. Without the *invention* of a new principle or a new modification, the ablest constructor would hardly be able to make any very great departures from well-known systems. Due credit should therefore be given to the inventors as well as the constructors.

In support of the claims made in the concluding paragraph of Mr. Brown's communication, quoted above, that gentleman has asked us to publish the following letter which explains itself :

> I should like to make a few remarks on Mr. Carl Hering's comments on my letter of the 12th October last.
>
> I would first draw his attention to the concluding paragraph of that letter; and secondly refer him to Mr. Tesla's patents for the three-phase current filed October 12, 1887, Nos. 381,968 and 382,280, and his further patent No. 390,414, filed April 23 of the following year, of the existence of which patents Mr. Hering seems to be ignorant. For his further edification I enclose sketches which are fac-simile copies of drawings in the patents above referred to.
>
> I think that he should then see that I have done full justice to the true inventor of the three-phase current system.
>
> C. E. L. Brown
>
> Baden, Switzerland, Jan. 6, 1892.

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VOL. XIII. NEW YORK, JANUARY 27, 1892. No. 195.

The meaning of pure scientific discovery is very frequently misunderstood; one of the most common mistakes is to confound it with invention. The former, however, consists in finding new truths of nature, whilst the latter consists in applying those truths to some desired purpose.—George Gore.

THE LAW OF HYSTERESIS.

THE American Institute of Electrical Engineers has been the medium for bringing out not a few papers of scientific interest and practical importance, but we believe that none of more absorbing interest and practical utility has been presented to the Institute than that of Mr. Charles P. Steinmetz last week on the Law of Hysteresis. There was a time when the loss in the iron of dynamo electric machines, though recognized, was overshadowed by the importance attached to the losses encountered in the copper employed in the construction of such machines, but with the advent of the alternating current and the later developments of continuous current apparatus, the phenomenon of hysteresis and loss due to it at once rose to the highest practical importance as a factor largely influencing their efficiency. It is now generally recognized that in alternate current transformers the loss in the iron represents by far the larger part of the whole loss of energy. This iron loss, which, heretofore, may be said to have been practically unknown, and could be determined by experiment only, is now first expressed by Mr. Steinmetz in analytical formulæ of very simple form, so that we are enabled to calculate the loss in iron with the same exactitude as we have been able, for a long time, to calculate electric resistances. Thus we can now determine what change in the efficiency of the apparatus will be effected by a change in the magnetization, and hence also we can choose the kind of iron most economical to employ. But aside from alternating apparatus, hysteresis and eddy currents play an important part, for instance, in the armature cores of continuous current dynamos, and it is of great interest to see these important, but as yet little known, phenomena here yield to mathematical formulation. We are sure that electrical engineers will feel a sense of relief in having finally gotten rid of another factor of uncertainty in the designing of such machines.

It is interesting to note that the loss of hysteresis per unit of time is directly proportional to the number of periods and changes with the magnetization, so that doubling the intensity of magnetization very nearly trebles the loss; while the energy of consumption by eddy or Foucault currents is proved to be proportional per unit of time to the square of the frequency and of the magnetization, so that doubling the magnetization quadruples the loss by eddy currents. Mr. Steinmetz thus proves that eddy currents will be specially marked when high frequencies and high magnetizations are employed, and will practically disappear for low frequencies and low magnetization; while, on the contrary the hysteretic loss is still quite considerable even for low frequencies and low magnetization, indeed even for such extraordinarily low magnetization as 85 lines of magnetic force per square centimetre.

But from another point of view also this law of hysteresis is of the highest scientific interest, as was pointed out by Mr. Steinmetz in the discussion of his paper. While the law of conservation of energy teaches us that energy is indestructible and convertible into other forms of energy, Clausius' Law of Entropy proves that none of these conversions of energy are completely reversible, so that in any cyclic process, such as that met with in the alternating current transformers, etc., between electro-dynamic energy and magnetic potential energy, there is also a part of the energy lost, being dissipated as heat. This is the reason why a moving pendulum or an oscillating spring comes to rest, and why an electrically oscillating condenser discharges. But in none of these cyclic processes has it been possible heretofore to calculate exactly, and to formulate analytically, this law of nature, which determines the law of energy by conversion into heat; hence the electro-magnetic cycle is the first cyclic process in which the law has been determined, and in this case shown to involve the 1.6th power.

Besides this chief result, Mr. Steinmetz' paper contains a large amount of data of great value. Thus, for the telegraph engineer the cyclic curves will afford useful information on that most troublesome property of electro-magnets, namely, remanent magnetism. Of considerable interest also are the tests made on magnetic iron ore as they are, so far as we know, the first exact determinations of its magnetic properties. Though the first known magnetic body, magnetic iron ore, has not received its due consideration, and its magnetic behavior may be said to be as little known as it was 2,000 years ago, all that we knew being, that it was permanently magnetizable,—the tests on this material show at once the fallacy of the usual assumption as to the high remanent magnetism of magnetic oxide, and prove that its remanent magnetism is even lower than that of any other of the materials given in Mr.

Steinmetz' paper. It is also shown conclusively that the magnetic properties of iron and steel are influenced far more by their physical than by their chemical nature. The paper also deals with a number of what may be characterized as magnetic superstitions, such, for instance, as the lower hysteresis of the open magnetic circuit and of loaded [transformers, which must now be considered as definitely disproved. Mr. Steinmetz' paper also contains the first scientific researches made by means of the Eickemeyer differential magnetometer, first described in our columns some time ago; and the results obtained are such as to place this instrument among the most useful for scientific research.

"ELECTRIC POWER TRANSMISSION" AT THE CHICAGO ELECTRIC CLUB.

The last meeting of the Chicago Electric Club was made the occasion of what might be called a joint debate by the adherents of the alternating and direct currents as methods of effecting electric power transmission. The argument for the alternating current was made by Mr. William Stanley, Jr., who, after describing the new alternating motors designed by him in connection with Mr. John F. Kelly, took up the question of distribution and showed that the greatest difficulty in this direction lay in the cost and maintenance of working feeders from large stations. Mr. Stanley claimed that with a potential of 5,000 volts, the cost of copper mains for distances not exceeding 2,000 yards from a station was comparatively insignificant. As regards the method of employing this voltage, he advocated the installation of sub-transformer stations which would convert the pressure of 5,000 volts to one of 1,000, which could be distributed locally from that point. Admitting a loss of one per cent. in the iron and one per cent. in the copper, Mr. Stanley claimed that these sub-transformer stations could be operated at an efficiency of 98 at full load, or 93 or 94 at quarter load, and that the efficiency of the entire system from station to consumer might readily be 90 per cent. for very considerable distances, with proper designing.

Mr. Alexander Dow, who took up the subject as the advocate of the continuous current, argued that the saving in copper advocated by the employment of high-tension alternating current was not so great as that generally claimed for it, and that, in fact, the outlay for copper even for low-tension work constituted but a small fraction of the total cost of the distribution system, and this was especially the case when underground conductors were employed. He considered the question of the commutator as not so serious a matter as it is usually deemed to be, and the results of inquiries which he made on the subject would seem to show that up to 5,000 volts there is no serious difficulty in operating them, at least with a 10 ampere current, and even with 40 amperes. Prof. D. C. Jackson, who took part in the discussion, believed that the economical limiting distance for 1,000 volts at the motors is shown by practical experience to be about four miles, which, however, might be considerably exceeded under special conditions, particularly in small plants. Referring to the three-phase motor exhibited in Frankfort, Prof. Jackson gave it as his opinion that before such motors could be satisfactorily employed in this country, the rate of alternations now used in commercial work would doubtless have to be reduced, at least for circuits intended for power transmission. Indeed he thought that this was the reason of the failure of American companies to supply an alternating motor up to the present time.

THE MORSE TELEGRAPH SYSTEM IN AMERICA.

The admirable description of the new office equipment of the Western Union Telegraph Company in this city from the authoritative pen of Mr. Alfred S. Brown, the electrical engineer of the company, will give a good idea of the latest improvements which have been introduced with a view of reducing the business of telegraphing to its most effective point, considered from the standpoint of a telegraph central station. Perhaps the most noteworthy detail, and one which will appeal most strikingly to the telegraphist, is the fact that at this, the greatest telegraph centre in America—and the largest in the world, with perhaps one exception—the last voltaic cell has been finally discarded, even locals being operated from dynamo machines. There was, of course, no good reason why this should not have been done some time ago, but it is nevertheless gratifying to note that the opportunity afforded in the present instance was availed of. But looking further into the possibilities which the new equipment offered for the introduction of what are considered improved methods of telegraphic transmission, such as are embodied in the numerous multiplex and high speed systems now available, it is not unnatural to suppose that many might inquire why these systems did not find a place after their demonstrated success in other countries, abroad. Without attempting to answer this question here, the present equipment of the Western Union office is, we think, a tolerably sure indication that the Morse system, as such, will continue for a long time to be the standard system employed in this country. It certainly has stood the test of time wonderfully well, and in that respect probably stands unparalleled as an instance of a method which has, by the sheer weight of its practicability and simplicity, remained without a rival for over 50 years.

While we believe that the Morse, as a system, will long retain its hold in this country, we are not, however, quite so sanguine that the details of the apparatus employed in carrying it out will remain so firmly fixed. Indeed we believe that a change may be looked for at no distant date, the influence of which we are certain will be far-reaching and will serve to overcome many of the difficulties which are still met with in telegraphy, and which are due largely to the present type of instruments employed in carrying out the Morse system.

From the fact that Mayor Boody has wisely decided not to offer a second veto to the resolutions permitting the street railways in Brooklyn to introduce the trolley system, it is now safe to assume that the work will go ahead vigorously. This is an eminently satisfactory result, and we now expect to see other cities, such as Philadelphia, follow Brooklyn's example, and fall in line as users of electricity for heavy passenger traction.

THE BURTON SYSTEM OF ELECTRICAL FORGING.

IT must be clear to any one who is conversant with the details of the Patent Office, and who has followed during the past few years the numerous electrical patents granted, that the heating of metals by electricity has taken a distinct place in the inventions of the day. That electricity is peculiarly adapted for this purpose can easily be understood, as it necessarily eliminates many of the disadvantages which accrue from the old familiar mode of heating in furnaces of various kinds. At the same time there have been so many difficulties to overcome and so few practical results have been obtained with the exception of one or two notable cases, that the public are slow to believe that electric heating can be commercially successful. Electric welding, for instance, is well understood and has taken a distinct place in the manufacturing processes of the day. Electric heaters for ordinary work, such as heating houses, cars, cooking, etc., are also becoming well and successfully used, and can be procured as readily as a cooking stove. We propose in the following article, however, to describe more particularly a process by which metals can be speedily and accurately raised to any desired heat for forging purposes, and to give in detail a description of the Burton system of electrical forging, or more correctly the system of heating metals to such a heat that they can be readily forged by the special mechanical forging machines which are situated in the vicinity of the electrical apparatus. This system is controlled by the Electrical Forging Company of 163–167 Oliver street, Boston, which has a capital of $2,000,000, and it embraces numerous inventions of Mr. George D. Burton, the well-known inventor of the Burton stock car, and of many other well-known and useful mechanical and electrical appliances. The patents owned by this company also cover the mechanical application of the process to machines, enabling the automatic electrical heating and working of metals into any desired shape. These machines, one of which is shown in Fig. 5, page 90, are of special construction, and can be adapted to the production of any desired form or bulk of metal. Before describing further the nature of the work which may be carried out by this process, and the advantages which it possesses over other methods, we will describe in detail the plant which has been erected in Boston, and which has attracted a vast amount of attention in the scientific and engineering world. Fig. 1 is a general view of the generating-room on the first floor of building, and shows also one of the converters and a number of special machines for shaping the metal after heating. It should be stated here that from the first, alternating currents have been used in conjunction with large converters capable of developing enormous ampereage. The generating plant, proper, is contained within the portion of the building surrounded by a railing, as shown in the drawing, and consists, first, of a 60 h. p. Thomson-Houston motor, which receives its current from the regular street circuits of the Edison Illuminating Company of Boston. This motor is belted to a line of shafting carrying one Emerson power scale with meter attachments for accurate measurement of horse-power consumed. From this line of shafting is driven the 60 h. p. alternating generator, specially manufactured by the Eddy Electric Manufacturing Company, of Windsor, Conn., for the Electric Forging Company, and also a small exciting machine for the fields of the generator as shown in Fig. 1, but more clearly shown in Fig. 2. This main shaft also drives the line of shafting shown at the top of Fig. 1 which operates all the tools and forging machines both on this floor and in the basement below. The generator is specially wound to develop 24 amperes at 1,500 volts, and the current is controlled by a two-way switch, which throws it either into the converter shown in upper right-hand corner of Fig. 1 shown in detail in Fig. 3, or into the converter in the basement as shown in Fig. 4. Following the path of the current in Fig. 1, it is then brought to a switch and rheostat underneath the converter, and then passed up into the converter, an outside view of which is shown, suspended on beams from the girders above. This converter is of special design, different from anything before manufactured, and was also made by the Eddy Company. It consists of 14 coils in the primary circuit, through which flows the primary current, and 14 large secondary coils,

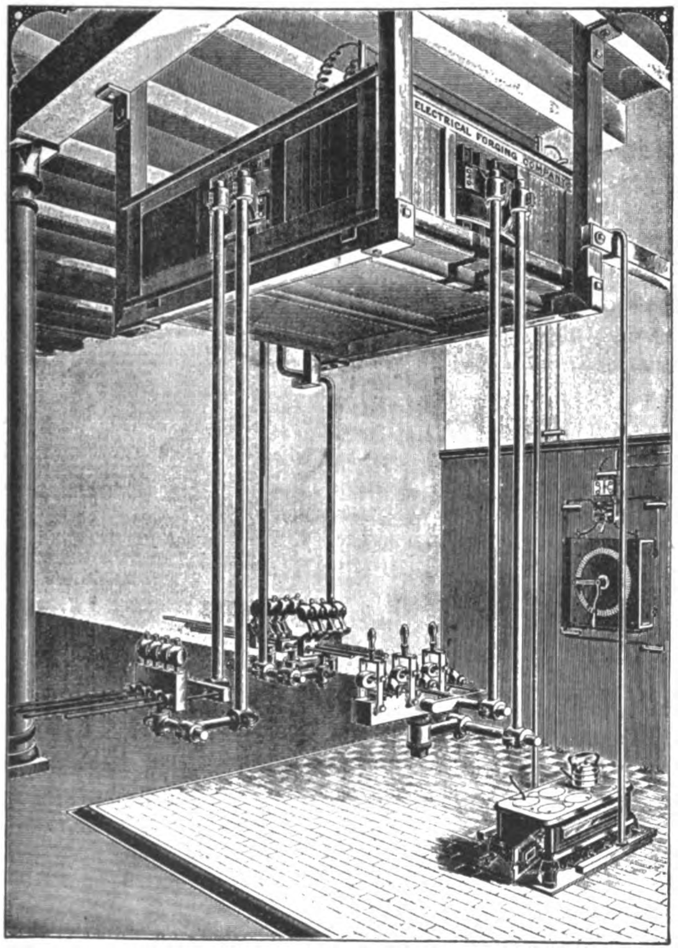


Fig. 3.—Large Forging Converter and Adjustable Clamps.

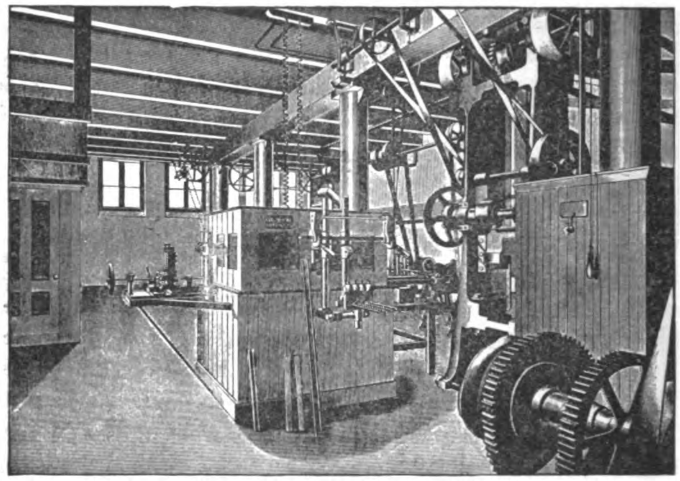


Fig. 4.—Converter in Basement, Burton Electric Forging Works.

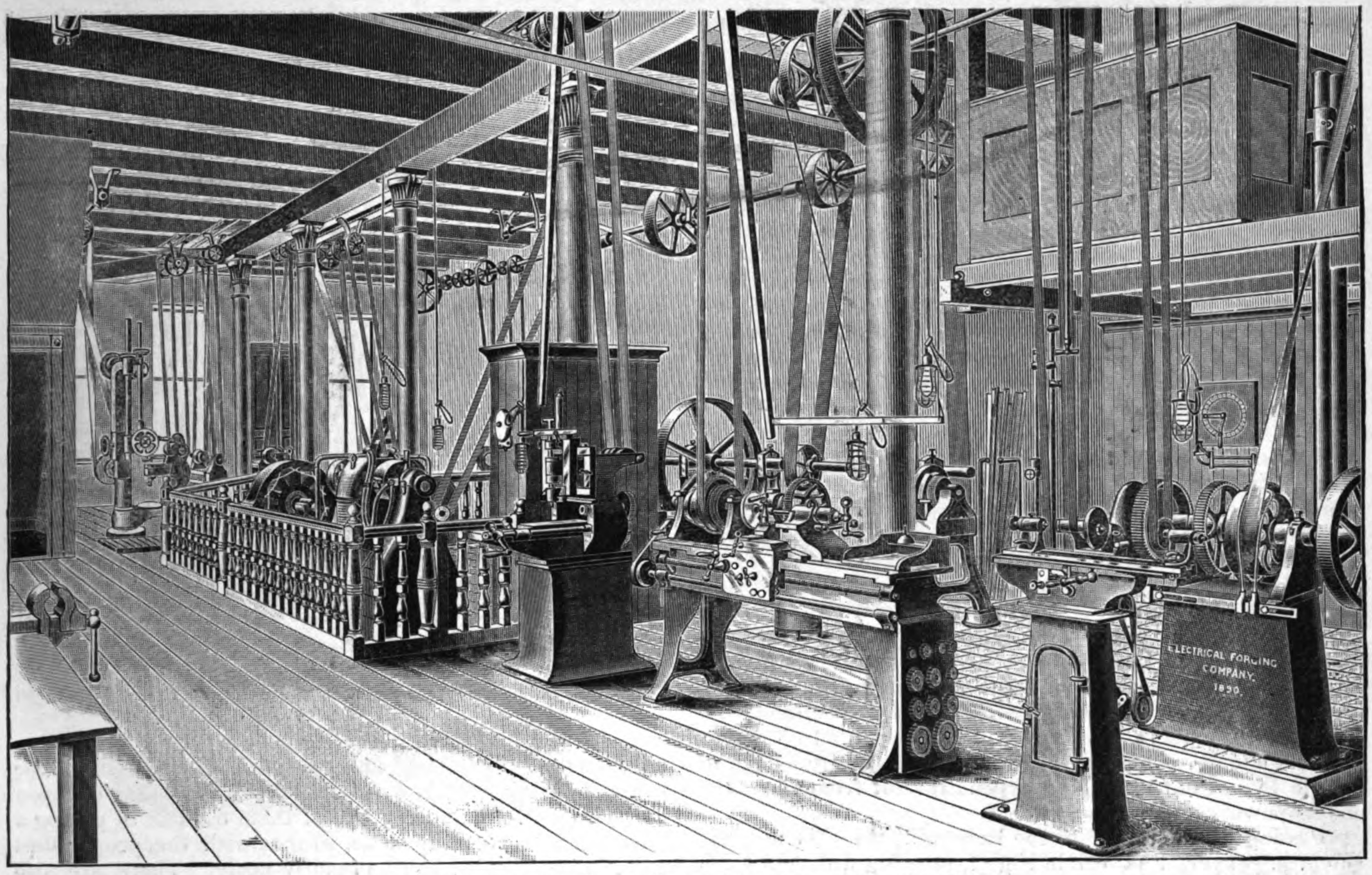


FIG. 1.—GENERATING ROOM, BURTON ELECTRIC FORGING WORKS.

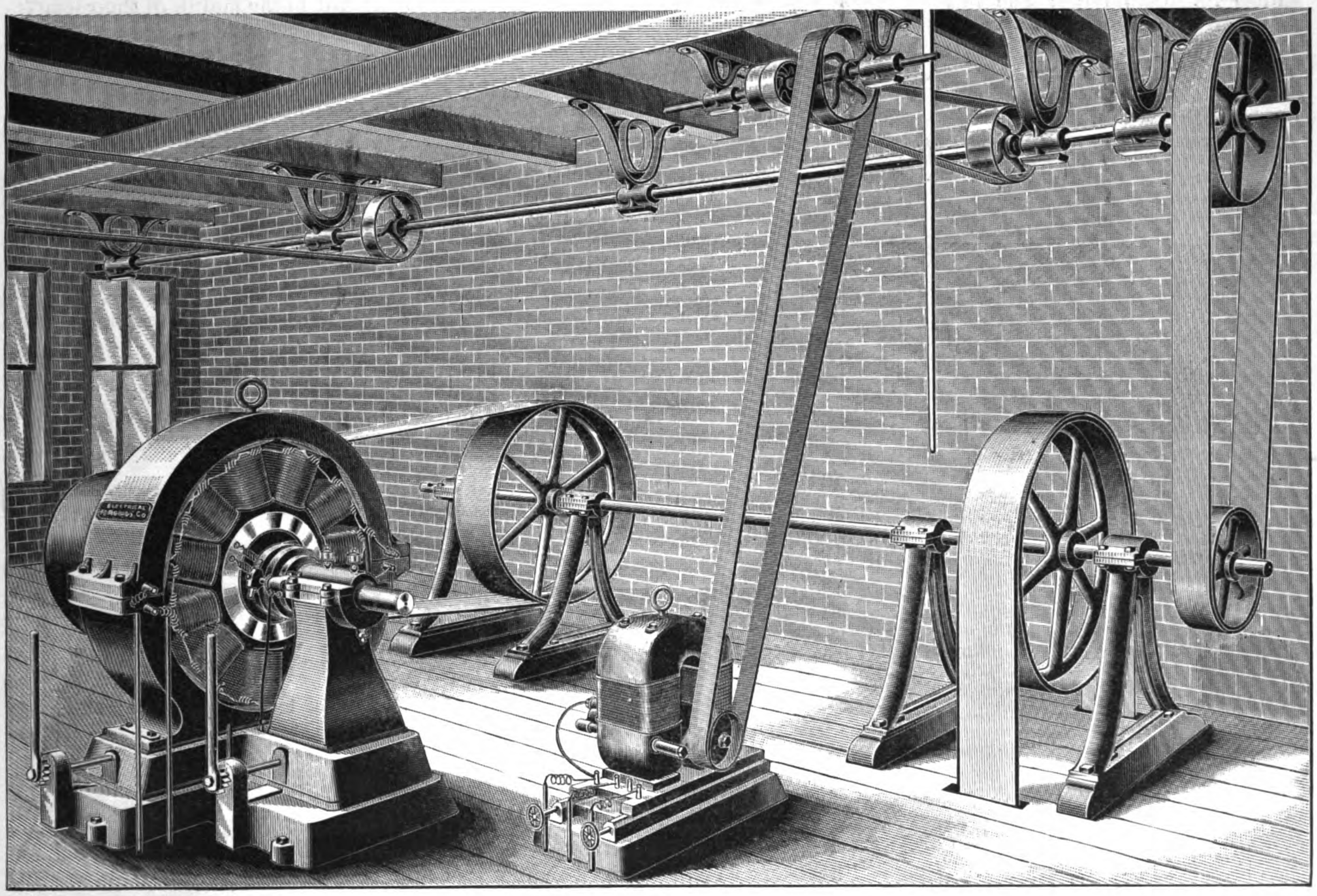


FIG. 2.—EDDY ALTERNATING GENERATOR AND EXCITER, BURTON ELECTRIC FORGING WORKS.

all of which are connected by special arrangement to the massive positive and negative conductors, which are composed of heavy copper rings, encircling the whole structure.

The converter has a capacity of about 60 h. p., and is designed to deliver current at 5 volts and from 5,000 to 8,000 amperes. From the rings above described, this enormous current is conducted by three sets of heavy copper bars, (as shown in detail in Fig. 3) to special electrodes provided with automatic adjustable clamps, in which the heating of the metals takes place. These electrodes are, as shown in Fig. 1, conveniently situated amongst machines for rolling balls, rivets and other kinds of regular and irregular shapes, the metal being heated and then passed into the machine. The electrodes shown in Fig. 3 are of special design, and vary according to the kind of work to be done. In certain cases where end heat is required, the clamps on the electrodes of one polarity are provided with a number of holes, through which a number of metal rods can be inserted, as shown in the figure. When these rods come into contact with the electrode or clamp of the other polarity, they are heated in a few seconds to a forging heat and while one heated rod is being worked by the rolling machines, the other rods are in the process of being heated, the machines being thus fed with a constant supply of heated metal. The capacity of this converter is about 1¼ inch steel, round or square, and four bars of this size can easily be heated at the same time. A complete outfit, however, has recently been shipped to England, and another to Canada, which will heat bars up to 5 inches square, and three feet long, throughout its entire length in about five minutes, with an expenditure of from 75 to 100 horse-power.

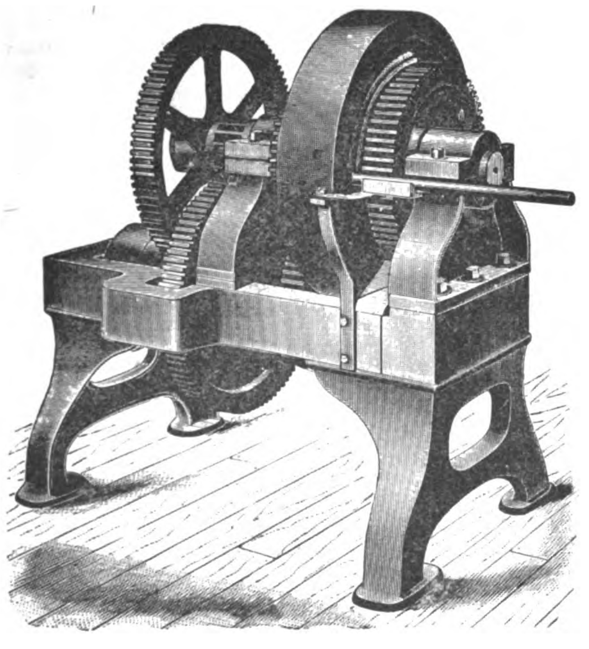


Fig 5.—Burton Electric Rolling Machine.

Passing down stairs into the basement, there is another 60 h. p. converter as seen in Fig. 4, showing different sides of the same type of converter, with a series of forging machines for doing larger and heavier work than those on the floor above and with a varied arrangement of clamps for special work. This converter has four sets of electrodes with clamps suitable for a varied class of work, and is designed for 2½ volts and from 8,000 to 12,000 amperes, having a capacity of heating to a forging heat a bar 1½ inches square, 20 inches long, in 5½ minutes with an expenditure of 42 h. p. In one case the set of electrodes has been specially designed to get an end heat on a bar of given size, and is also suitable for heating a bar throughout its entire length up to 24 inches. In Fig. 4 the electrodes shown on the left-hand side of the converter are designed for making coil springs, and for heating a moving bar 16 feet long its entire length as it passes through, into any form of mechanical forging machine. The electrodes shown in the middle of the converter in Fig. 4, are for heating rods for the manufacture of horseshoe nails, and also for general heating work. The electrodes on the right-hand side of the converter in Fig. 4, are of extra heavy copper 3 inches in diameter, and are for heating large stock for heavy forgings. This set of electrodes is placed between two heavy drop hammers, one of them capable of giving a blow equal to 60,000 pounds, so that with the proper dies any kind of forging can be readily made. There are also special sets of clamps for transverse currents, so that bars of metal can readily be heated in the middle of their length or at any desired place in their length. A glance at the figure will show a number of different machines for varied kinds of rolling and forging, including Bradley hammers, various punches, presses, rolling machines, machines for making balls for ball bearings, for rough and fine grinding, and a 10-ton machine for heavy forgings such as railway coupling pins, king-bolts, etc.

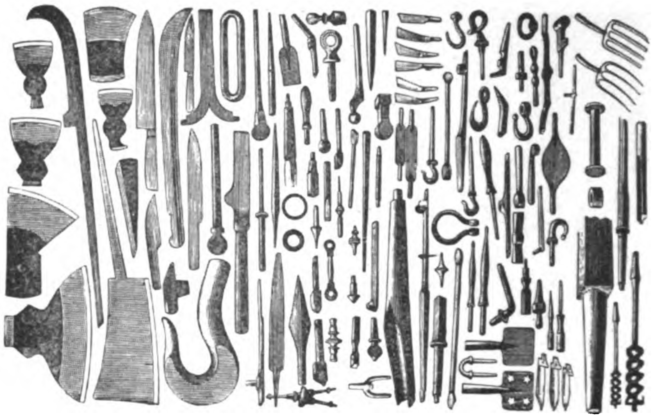


Fig. 6.—Hammered Pieces Made by The Burton Forging Process.

The shop is also well equipped with fine tools for the manufacture of all kinds of dies and the manufacture of the heavy copper clamps and conductors used on the converters. On the main floor is situated conveniently a draughting-room, where the drawings for the special machinery are made, and designs for applications to special purposes are carefully elaborated.

In order to give a better appreciation of what can be done by this process, a few cases may be cited:

(1) A round bar of tool steel, ⅞ inch diameter and 11 inches long between the clamps, is raised to the proper forging heat in one minute by 32 h. p.

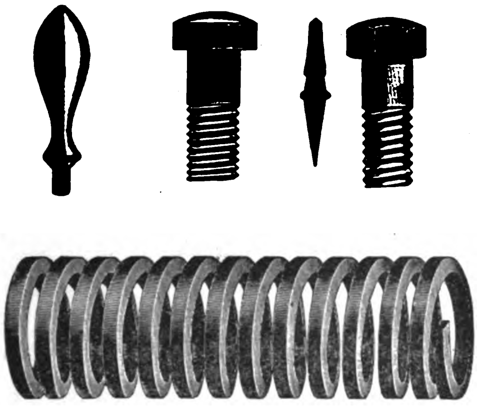
(2) A flat bar of machinery steel, ¼ inch thick, 1 inch wide, and 17 inches long, is heated in one minute by 34 h. p.

(3) Balling stock for balls, tool steel ½ inch diameter and 5 inches distance between the clamps, is heated in half a minute by 27½ h. p. This heat can be maintained for any length of time, by means of a perfect controlling apparatus, the heat on the metal during that time remaining perfectly constant.

(4) A bar of machinery steel 1 inch square and 12 inches long, is brought to a white heat in two and a half minutes by 36 h. p.

Taking the last case for an example, and two pounds of coal as a fair average per hour per horse-power, we have 72 pounds of coal used per hour for the 36 h. p., which is equal to a consumption of about three pounds of coal for the two and a half minutes.

One of the great advantages of the electric system of heating, lies in the evenness with which the metal is heated, the interior of the metal being heated first, and then extending uniformly and gradually over the whole mass. By this means objects can be forged by the electric process in one heat, which before required two or three heatings in furnaces. Owing also to the even heating, the metal forgings are much more reliable, the metal being subjected to no unequal strain either in heating or cooling. The quickness with which any piece of metal is heated by the electric current is also advantageous in many cases, as a few inches back from the part under treatment the metal is quite cool and can be conveniently handled. Probably one of the greatest advantages, however, lies in the fact that during the process of heating there are no gases developed, nor is there any foreign substance present to enter into the metal. So that whether the metal be iron, steel, brass or composition, after being heated electrically it is entirely without scale, which is impossible by any other method.



Figs. 7 and 8.—Products of the Electric Rolling and Coiling Machines.

The economy of electric forging is a subject well worth studying, and a few of the claims urged for this process may be here enumerated. First, there is the economy of space, no provision having to be made for large furnaces, and consequently more room can be allotted to the metal-working machines. Then there is great economy in the fuel, as the fuel, instead of being scattered in a number of different forges, is concentrated in one boiler furnace. There are also no ashes to be withdrawn from forges, nor fuel to be brought to them, thereby effecting a large saving in time and labor. The simplicity of the machine is another factor in its favor, it being extremely easy to operate and under perfect control, and after a few pieces of metal of certain size have been heated, the machines can be set to act perfectly automatically and without any skilled assistance.

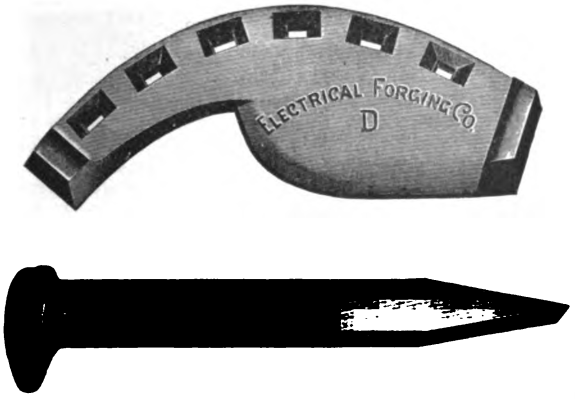


Fig. 9.—Electric Drop Forged Ox Shoe and Railway Spike.

We give herewith a number of illustrations that show tools, etc., made by the Burton process. The initial letter of this article is an ordinary wrench made by drop forging. Fig. 6 gives a collection of hammered pieces. Fig. 7 shows a spring made by the coiling machine, and Fig. 8 shows some bolts with either hexagonal or round heads made by the rolling machine. Fig. 9 shows an ox shoe and a railroad spike made by electric drop forging.

Mr. Burton is to be congratulated upon his perseverance in endeavoring to solve the problem of electrical heating and on his success; and the Eddy Electric Manufacturing Company also deserve great credit for materially assisting Mr. Burton in designing the apparatus for producing the heat, apparatus which not a few electricians claimed to be impracticable and impossible.

ON THE LAW OF HYSTERESIS.[1]—I.

BY CHAS. PROTEUS STEINMETZ.

In the number 137, of December 17th, 1890, of The Electrical Engineer I published a short article under the title "Note on the Law of Hysteresis," where I showed that in a set of determinations of the loss of energy due to hysteresis by reversals of magnetism, for different magnetizations, made by Ewing, this loss of energy due to hysteresis can fairly well be expressed by the equation:

$$H = \eta\, B^{1.6},$$

where H is the energy consumed by the hysteresis during one magnetic cycle, in ergs per cubic centimetre, B the magnetization in lines of magnetic force per square centimetre, and η a numerical coefficient, in this case $= .002$.

Considering that even the simple law of magnetism—that is, the dependence of the magnetization B upon the magneto-motive force F has until now defied all attempts at mathematical formulation, it appeared a strange feature that the apparently much more intricate phenomenon of hysteresis, or rather of the consumption of energy by hysteresis, should yield to analytical formulation in such a simple way, to be directly proportional to the 1.6th power of the magnetization. At the same time the coincidence of Ewing's tests with the curve of the 1.6th power was near enough to be considered as something more than a mere incident, but at least as a clew to a law of hysteresis, the more as this law held not only for low and medium magnetization, but even for very high saturation, without showing any kink at that point where the magnetic characteristic goes over the bend or "knee" and thereby entirely changes its shape, nor any marked tendency of deviation of the extremest observed values from the calculated curve.

To study more completely this phenomenon of hysteresis and of the energy consumption caused thereby, I set about to make a number of determinations with different magnetic circuits and at different magnetizations.

To be enabled to carry out these experiments, I am highly obliged to Mr. Rudolph Eickemeyer, of Yonkers, N. Y., who being greatly interested in the laws of the magnetic circuit and having done considerable work himself in this branch of electrical science, not only put the large facilities of his well-known factory at my disposal, but also guided the experiments with his valuable advice. A part of the instruments used in the tests are of Mr. Eickemeyer's invention and covered by his patents.

To be able to deal with readings of considerable power-values, where a much greater exactness can be reached, and at the same time to determine the dependence of the hysteretic loss of energy upon the velocity of the magnetic cycles, I decided to use alternating currents, at least as far as this could be done, whereby the determinations of the energy consumed by hysteresis is reduced to a simultaneous watttmeter, voltmeter, ammeter and speed reading.

Suppose, around a magnetic circuit, an alternating current of N periods per second is sent in n convolutions.

Let C = the effective strength of the current,
E = the effective E. M. F. induced in the circuit by self-induction, after subtracting the E. M. F's induced by the self-induction of the instruments.
W = the energy consumed in the circuit, after subtracting the energy consumed by the electric resistance,

Then l being the length and s the cross-section of the magnetic circuit, all in centimetres, amperes, volts, watts, etc.,

Let B = the maximum magnetization in lines of magnetic force per square centimetre,
H = the loss of energy by hysteresis per cycle and cubic centimetre; then

$$W = l\, s\, N H \times 10^{-7}$$

hence

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[1] Abstract of a paper read at the sixty-third meeting of the American Institute of Electrical Engineers, New York, January 19th, 1892.

$$H = \frac{W}{l\,s\,N} \times 10^{+7}$$ the hysteretic loss of energy, and

$$E = \sqrt{2}\,\pi\,s\,B\,N\,n \times 10^{-8}\text{; hence}$$

$$B = \frac{E \times 10^{8}}{\sqrt{2}\,\pi\,s\,N\,n}\ ^{(2)}$$ the maximum magnetism.

For higher frequencies, 80 to 200 periods per second, the alternating current was derived from a 1 h. p. 50 volt Westinghouse dynamo. This was driven by a 3 h. p. Eickemeyer continuous current motor. By varying the excitation of the motor field and varying the E. M. F. supplied to the motor, the speed, and therefore the frequency of the alternating current, could be varied within wide limits.

For low frequencies, this bipolar continuous current motor was used as a bipolar alternating dynamo, as shown in a patent of Mr. Stephen D. Field. On the continuous current commutator two sliding rings were mounted and connected with opposite commutator bars. In the ordinary continuous current brushes a continuous current was sent in, which set the machine in motion as an electromotor, while from the sliding rings by two separate brushes, alternating currents were taken off. By varying the E. M. F. supplied to the motor, the E. M. F. of the alternating current was varied, while a variation of the motor field gave the variations of the frequency. The curve of E. M. F. was very nearly a sine-wave, the ratio of maximum E. M. F. to effective E. M. F. found = 1.415, while the sine-wave requires 1.414—that is, exactly the same.

To determine whether the change of the shape of the alternating current by varying load and varying excitation had any influence upon the readings, the variations of the alternating E. M. F. were produced in several different ways.

But after having found that all these different ways of varying the alternating E. M. F. gave no perceptible difference whatever in the readings, I afterwards used the most convenient way to vary the excitation of the dynamo field and, where higher E. M. F's were needed, to increase the E. M. F. by an interchangeable converter.

For the electric readings, instruments of the electro-dynamometer type were used, zero-reading—that is, the movable coil was carried back by the torsion of a steel spring to zero position. These instruments were specially built for alternating currents, with very low self-induction and low internal resistance, using bifilar german silver wire as additional resistance.

In most of the readings sufficient additional resistance was used to make the correction for self-induction negligible. Only in a few readings where it exceeded 1 per cent. was it taken into account. These instruments were calibrated several times and their constants found to remain constant.

The speed indicator was calibrated carefully and its corrections added. Each reading consisted of an ammeter reading, a voltmeter reading, a wattmeter reading and a speed reading.

Before and after each set of readings the zero positions of the instruments were determined, and only those sets of readings used where the zero position had remained constant.

Before and after each set of alternating current readings a continuous current was sent into the circuit and a few readings for different currents taken. Voltmeter and ammeter readings combined gave the resistance of the circuit, and both combined with the wattmeter reading gave a check for the instruments, there being watts = volts × amperes. Only those sets were used again where an entire agreement was found, and with the alternating current first readings with small currents, then with large currents, and then again with small currents were taken, so that I believe that every possible care was exercised to avoid any errors in the tests.

The first sets of tests were made on the magnetic circuit of a small Westinghouse converter, which contained 917 cm.^{3} of iron, of a magnetic cross-section of 43.67 cm.^{3}

Further sets of readings were taken on a magnetic circuit, built up of very thin sheets of iron, in rectangular shape, very carefully insulated against eddy currents with layers of thin paper between the sheets, and excited by 100 turns of wire.

The whole volume of iron was = 155 cm.^{3}, its cross-section < = 3.784 cm.’, the thickness of the sheets $\delta = .0258$ cm. In one set of tests an open magnetic circuit was used.

In these readings, for the determination of the hysteretic loss, only voltmeter and wattmeter, but no ammeter, were used, and the susceptibility curve determined separately by voltmeter and ammeter.

THE GOVERNMENT TO CONTROL THE TELEPHONE IN BELGIUM.

THE government has notified the Bell Telephone Company, whose instruments are now used in Belgium and which is at present doing all the telephone service, that on and after the 1st of January, 1892, the government will assume and conduct the service.

Society and Club Notes.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

MR. GEORGE F. PORTER, the secretary of the association, is rounding up non members in the central station field with the following practical appeal:

> "Great interest is being taken in the coming fifteenth convention of this association, to be held in Buffalo, N. Y., February 23d, 24th and 25th next. Knowing you to be interested in central station management, I take the liberty of calling your attention to the great benefits accruing from attending these meetings. The papers to be read at Buffalo are from men high in the science, and will treat on every valuable subject from 'How to Fire a Steam Boiler' to 'Electric Lighting from a Financial Standpoint,' including the steam engine, dynamo, switchboards, overhead and underground wiring, motors, etc. We would be pleased to enroll you among our already large membership, and hope to welcome your representative at Buffalo."

PHILADELPHIA NOTES.

THE WRIGHT & STARR ELECTRIC CO. has been incorporated in this city with a capital stock of $250,000. At a stockholders' meeting held last week Mr. B. F. Morley was elected president, and Mr. J. G. Dyer, secretary and treasurer, for the ensuing year. The company will act as sole agents for the Waddell-Entz Eelectric Co., of Bridgeport, Conn., for the States of Pennsylvania, Delaware, Maryland, District of Columbia, Virginia and West Virginia, and are prepared to equip street railways with their storage battery system. Their experimental car "Direct" has been running in Chester successfully for several months, and the batteries have proven to be very durable.

MR. OTIS K. STUART, the agent for the Germania Electric Co. in the Southeastern district, is receiving a large number of inquiries concerning the Freeman transformer. He says alternating current men like the circular form of this transformer and the "removable plug" which the fuses are arranged on. This plug can be wired in the station and when a fuse "blows" out it can be replaced without danger to the lineman.

MR. GEO. W. LA RUE, general sales manager for the Crocker-Wheeler Electric Co., made this office a call last week while on a business trip to all the coast cities between New York and the gulf. He reports a promising outlook for business.

MR. B. B. STODDARD, of the Germania Electric Co., paid a flying visit to this city this week. He says business is very good and that their company is making rapid progress in fitting out its large new factory in Marlboro, Mass.

WASHINGTON NOTES.

THE HANSON BATTERY CO., of Washington, D. C., have been remarkably successful with their new primary battery, they having accomplished with it everything thus far undertaken. A handsome electric launch is now being fitted up with their new batteries, which can soon be seen running on the Potomac.

CONGDON, BLISS & DANIELS, contracting and consulting engineers, have recently opened offices in the Atlantic Building, Washington, D. C. This new firm, which was organized the first of the month, has the agency for the Heisler system of lighting and the "Quaker City" dynamos and motors for the District of Columbia, Virginia, West Virginia, North and South Carolina, Kentucky, Tennessee. Florida, Alabama and Georgia. They will do expert work and contracting and will make a specialty of general electric work. Mr. Congdon has had large experience in the business world, having been employed as correspondence clerk for the Edison Machine Works, New York, Randolph & Clowes, Waterbury, Conn., and as Assistant Chief of the Supply Division, War Department, at Washington. Mr. Bliss is an expert electrician and was contracting agent of the Edison General Electric Co.; while Mr. Daniels, was electrician of the White House and State, War and Navy Department Buildings.

They are all men of energy and business capabilities and well known in the electric field. They make an announcement in this week's issue of THE ELECTRICAL ENGINEER to which attention is called.

CONGDON, BLISS & DANIELS, Washington, D. C., report extraordinary success. Among the many and important contracts in hand and closed are a complete plant of the Heisler system for Lambertville, N. J., $26,450; wiring of Oregon Flats, Typographical Union Building, and Ohio Bank Building; Norfolk and Washington Steamboat Company's steamer, "Geo. Leary," complete isolated plant.

THE WESTERN UNION TEL. CO. will have to pay $60,000 with interest and costs in the appeal of James E. Goodsell for an old press contract that was allowed to fall through about ten years ago and has been in litigation ever since.

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[2] This formula holds rigidly only for the sine-wave, but, as shown in the following, the currents used in the tests were at least very near sine-waves. Besides, a deviation from the sine shape would not alter the results at all, but only slightly change the coefficient η.

TESTS OF MILLIKEN STREET RAILWAY POLES.

It has long been a question among engineers building electrical street railways as to what is the best form of pole to use, giving the greatest strength and least deflection. The questions of strength and deflection are of the greatest importance, for the reason if the trolley and guard wires are not tight and are not kept tight they will sag, and not only become dangerous but will need constant attention. What is wanted is a pole that will act like a bow or spring, and keep a tension on the line at all times and of sufficient amount to hold the trolley and guard wires in position at a fixed height above the tracks. With a view to ascertaining the best form and proportions of a pole adapted to street railway work, Messrs. Milliken Bros., of New York, have during the past year submitted this question to Prof. R. H. Thurston, of Cornell University, at Ithaca, N. Y., who has carried out a series of tests, the results of which are of great interest and importance to electric railway managers.

The object of the test being to find the pull the pole would stand, and its deflection, the base was placed on the platform of the transverse testing machine, and a fulcrum formed by a tie rod of iron bolted to the base of the scale, as shown in the accompanying engraving. The load was applied to pull the top of the pole up, which, acting against the fulcrum 5′ 9″ from the support under the base, caused a stress on the platform of the testing machine in the proportion of 187 to 50, as compared with the pull at the top. The tangent of the angle of curvature was measured by observing three points, one each side of the fulcrum and 25 cms. apart; by this the actual deflection was corrected, since this curvature would tend to increase the deflection of the pole by an amount equal to the length of the overhanging part into the tangent of the angle as compared with a perfectly rigid support.

The first tests were made on a side pole as first made by Milliken Bros., *i. e.* with the lacing in the centre extending only to a tie plate at ground level. The tests showed that the strain revolved around the tie plate at ground level and buckled the segments. It proved that by continuing the lacing to the butt of the pole and filling same with concrete, that the pole would develop considerably more strength and at the same time add little to its cost. This form of construction was therefore adopted for standard work. In order to get at the exact strength, and to compare them with other poles, 5 Milliken poles and 3 pipe poles were furnished to Cornell University for testing, and they furnished a chestnut pole. The following is an extract from the report of the test:

The Milliken poles differed among themselves in weight and the arrangement of the "lacing" and the various "gusset-plates" used in the construction. The differences are detailed in the following table:

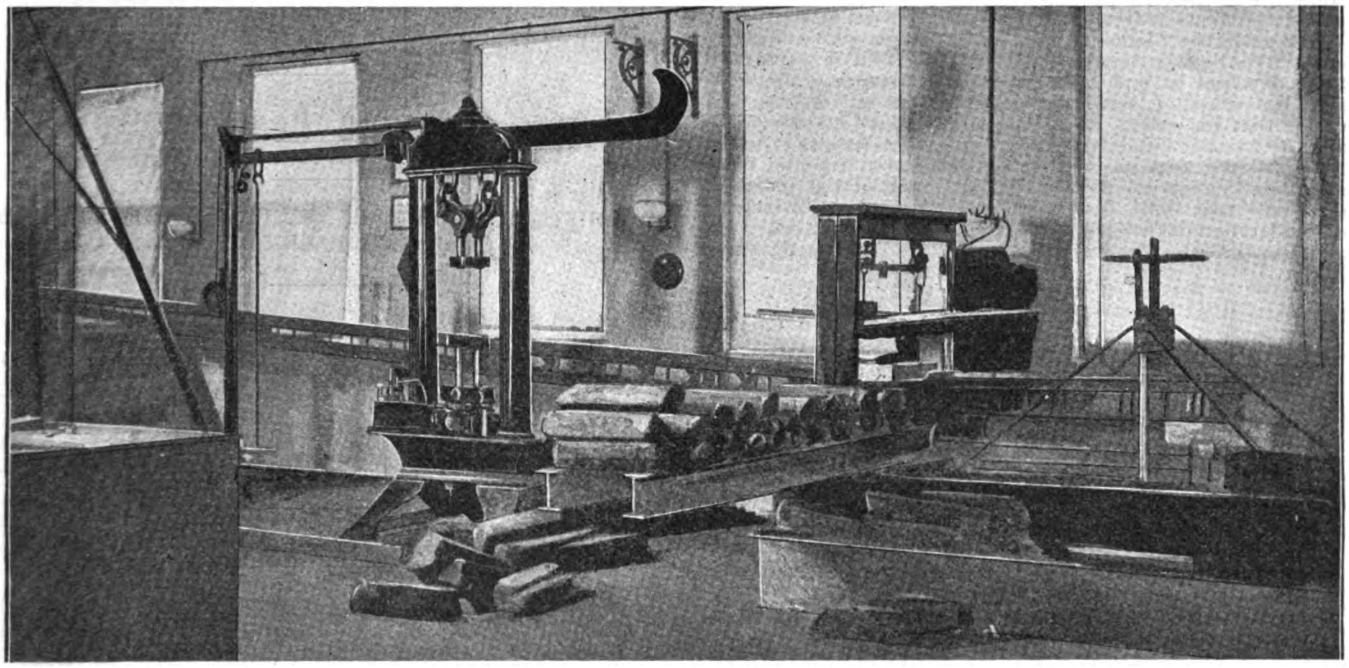
MILLIKEN POLES.

No. of Pole	II.	V.
Length over all	26 ft. 6 in.	28 ft. 6 in.
Length unsupported	20 ft. 7 in.	22 ft. 6 in.
Lacing from	Butt Plate.	Butt Plate.
To	Middle Plate.	Middle Plate.
Gusset-Plates between butt and top plates?	Yes.	No.
Butt filled with cement?	Yes.	Yes.
Standard Side Pole	Yes.	——
Stand Pull-Off Pole	——	Yes.

The "Pipe" poles are made by uniting three sections of steam or hydraulic pipe, of different sizes, telescope fashion. The joints are made in two ways according to the relative sizes of the pipes jointed; (*a*) by shrinking or forcing the large over the smaller, or (*b*) by driving a "liner" of proper thickness into the annular space between the two pipes. The principal dimensions of the pipe poles are as follows:

PIPE POLES.

No.	Length to Eye.	Length of Sections (apparent). I.	II.	III.	External Diameter. I.	II.	III.	Total Weight.
A.	27 ft. 3 in.	14 ft.	7 ft. 6 in.	5 ft. 9 in.	5½ in.	4½ in.	3½ in.	368 lbs.
B.	28 ft. 5 in.	14 ft.	7 ft. 1 in.	7 ft. 4 in.	6⅝ in.	$5\frac{9}{16}$ iu.	4½ in.	486 lbs.
C.	28 ft. 2½ in.	15 ft. 3 in.	5 ft. 9 in.	7 ft.	6⅝ in.	5½ in	4½ in.	750 lbs.
Chestnut	28 ft. 6 in,	About 10 in. at butt.						316 lbs.



View of Cornell Testing Room, Showing Milliken Pole During Test.

Poles II and V were filled in with Portland cement from the butt to a point 6′ from the butt. In all of the poles the unsupported length was from the eye to a point 6′ from the butt. The following are the results of the tests:

Pole	No.							
Pole	No. II	the elastic	limit	was	1540 lbs.;	corresponding	deflection,	10″
"	" V	"	"	"	3340 lbs.;	"	"	14′
"	" A	"	"	"	675 lbs.;	"	"	12.2″
"	" B	"	"	"	920 lbs.;	"	"	16.5″
"	" C	"	"	"	1420 lbs.;	"	"	13.6″
"	Chestnut	"	"	"	960 lbs.;	"	"	37″

When tested to destruction, Pole No. II broke by fracture of segments about 1′ 8″ in front of fulcrum. The segments were fairly pulled in two; plane of fracture at right angles to axis. Pole V gave a slight permanent set at fulcrum, preceded by cracking of cement near fulcrum. All pipe holes bent in second joint from one foot to three feet ahead of first joint or section of pipe. Chestnut pole yielded by opening slightly on under side, near fulcrum.

Referring to the tests, the pipe pole marked "A" is what is known as a 5″, 4″ and 3″ standard weight pipe, and is now not generally used in street railway work, as it is too light. Pole marked "B" is what is known as a 6″, 5″ and 4″ standard weight pipe, and is the one generally used in side pole construction of street railways. Pole marked "C" is what is known as a 6″, 5″ and 4″ extra strong pipe pole, and is used for pull off poles.

The Milliken side pole is thus shown to be stronger by 120 pounds than the extra heavy pipe pole, and the deflection of which is over 30 per cent. more than the Milliken. The Milliken Standard Side is 620 pounds stronger than the standard side pipe pole, and the deflection of the pipe is 65 per cent. more than the Milliken. The tests also show that the Milliken "Pull-off Pole" is 2¼ times as strong as the pipe pull-off pole, and the deflection of the same only measures $\frac{1}{16}$ of an inch more.

The conclusions deduced from experiments is best stated in the words of the report as follows (referring to the Milliken Standard Pole): "We now have a pole of as nearly homogeneous structure as possible, and for a given weight of iron of maximum strength." Referring to the Milliken Pull-off Poles, he states: "I reiterate my statement that the pole is stronger than can possibly be required for any work ordinarily connected with the carrying of wires."

Letters to the Editor.

A NOBLE SCOTCHMAN.

One of the New York electrical journals in referring to the honors recently conferred upon Sir William Thomson, says, among other things, that his "care for the bawbees results in frequent contentions with London cab drivers, etc." To the same cause is no doubt due a custom that Prof. Thomson has of treating his laboratory students to frequent excursions on board his handsome schooner yacht the "Lalla Rookh," where lunch, wine and cigars contribute to the enjoyment of the sail, Sir William paying all railway expenses to and from Glasgow, a distance of about 120 miles. His refusal of larger salaries from other universities, and the fact that his salary for those years in which his services in laying the Atlantic Cable interfered with his classes was returned to the university, together with an additional sum to found three scholarships in experimental physics, are some of the instances which show that Lord Thomson's mind is given exclusively to the consideration of the number of pennies in a shilling, when not engaged in enriching the world with his scientific investigations.

R. M.,
(Formerly student at the
Glasgow Physical Laboratory).

Baltimore, Md., January 17

PRAISE, PITH AND POINT FROM SIR HUBERT.

I have just finished my weekly perusal of the **Engineer** bearing date of to-day, and I cannot refrain from tendering my felicitations to you upon the very high grade of excellence reached in this number.

I think, taking it as a whole, and this after reading all the numbers which have ever issued, that this is the very best. The "Henry" article, is in its way so far as it has appeared, certainly a masterpiece, and though I question the propriety of making priority of discovery a question of National partisanship; and the expediency of asserting more for the great Henry than he did for himself, so far as I can ascertain; and though further, I think we already hold Henry so high that he requires no "vindication" to use your own word, yet I heartily admire the matter and manner of the article, as far as it has appeared.

The plea for the porcelain insulator by Mr. Jones equally enlists my sympathy; and I am glad to be able to cordially coincide with Mr. Park Benjamin in his sentiments regarding the necessity and the duty of keeping green the memory of William Gilbert, a man whom the great Galileo, the melodious Dryden, and the quaint Fuller alike delighted to honor.

I am glad for myself, to be able to say that I have always availed myself of opportunities to pay the tribute of full appreciation to the worth of Gilbert's services to electricity; and also to those of Gray, the discoverer of conduction and insulation.

Prof. S. P. Thompson, likewise, has manfully done his part for Gilbert, and before me at this moment, is a little book published last year by him, and entitled "Gilbert of Colchester, an Elizabethan Magnetizer," which proves that the sage is fully appreciated by Prof. Thompson, who moreover has rendered a public service in rescuing from comparative oblivion many interesting facts concerning another intellectual giant of the earlier days, William Sturgeon."

I have recently made some inquiries regarding the Gilbert society, and its translation of "De Magnete," and have been informed from thoroughly reliable sources, that the book is not lost sight of, and that the delay in its issuance is accounted for by the fact that its revisers are all very busy men who can only devote a small portion of time to that work.

Mr. Shaw's sketch and picture of Sir William Thomson compensate for what would seem to be the unnecessary slur of the Gilbert article upon the acknowledgment by the Crown of Sir William's great merit and ability, and I for one was profoundly interested in it, and consider myself favored in being permitted to read such an account so near first hand.

Thomas D. Lockwood.

Boston, Jan. 13, 1892.

VENTILATION AND THE SWEATING OF IRON ROOFS.

We note the communication in your edition of Jan. 7th, from Milliken Bros., in which they say that if an iron roof is properly ventilated that it will not sweat on the underside.

We dispute most emphatically this statement. The sweating process arises from the fact that cold air will not hold in suspension as much moisture as warm air. The warm air of the room coming in contact with the cold corrugated iron of the roof is cooled and as a result deposits a portion of its moisture on the underside of the corrugated iron, causing what is known as sweat or drip. Ventilation has nothing to do with it and will neither increase or decrease it. The only way to stop it is to put something under the corrugated iron to catch it or put some substance between the inside of the room and the corrugated iron which will act as a non-conductor and prevent the dripping.

In order to make a fireproof roof under these conditions this non-conducting material must be fireproof, otherwise you have not what might be called a strictly fireproof roof.

There are different ways of accomplishing this as already noted in former communications of ours.

Chas. M. Jarvis,
Pres. Berlin Iron Bridge Co.

East Berlin, Conn., Jan. 16, 1892.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JANUARY 12, 1892.

Alarms and Signals:—

Electrical Annunciator. W. F. Harte, 466,784. Filed July 25, 1891.

An automatic electrical hotel annunciator.

Automatic Electric Heat Alarm, M. S. Pierce, L. H. Desisle and O. C. Oliver, Filed Dec. 15, 1890.

Adapted for use in the journals of machines where injury is liable to be occasioned by overheating. See p. 96.

Annunciator, D. Heineman, 466,870. Filed Mar. 16, 1891.

A drop annunciator for hotels, etc.

Dumb Waiter Signal, F. J. Zahner, 467,073. Filed Aug. 14, 1891.

An electric signal for dumb waiters.

Conductors, Conduits and Insulators:—

Electric Insulator for Boilers, P. Decker, 467,085. Filed Sept. 25, 1891.

Claim 1 follows:

An electric insulator introduced in a pipe connection between a steam boiler and a steam engine to break an electric circuit between them.

Dynamos and Motors:—

Brush-Holder for Commutators for Dynamo-Electric Machines, I. H. Bartholomew, 466.972. Filed Aug. 13, 1891.

Method of readily adjusting the commutator brushes to compensate for wear.

Electric Motor, J. H. Palmer, 467.048. Filed March 28, 1891.

A motor in which the armature and field-magnets are both free to revolve in opposite directions.

Galvanic and Thermo-Electric Batteries:—

Electric Battery, J. S. Nowotny, 466,798. Filed Mar. 23, 1891.

Has for its principal object to obtain a maximum of surface for contact with the battery liquid.

Battery-Zinc and Method of Making the Same, J. Beattie, Jr., 466,820. Filed March 30, 1891.

An element for galvanic batteries consisting of an alloy of zinc, mercury and magnesium.

Heating:—

Electrical Heating Apparatus, A. E. Appleyard, 467,075. Filed Jan. 16, 1891.

Combination of a resistance, a rigid holder of refractory heat-conducting, insulating material, a metallic shell enclosing the holder and an outer metallic shell independently secured to the handle.

Measurement:—

Electric Indicator, C. W Holtzer & G. E. Cabot, 466,787. Filed Apr. 6, 1891.

Indicates variations of the electromotive force of currents in electric light and power installations.

Ammeter, C. F. Brush, 466,953. Filed Nov. 21, 1889.

An ammeter in which the strength of the current is measured by means of the different expansion of two dissimilar metals.

Metal-Working:—

Method of Electric Welding, P. Gendron, 466.825. Filed June 17, 1891.

A method of welding which restores the enlarged portion of the weld to the original size and shape of the pieces welded.

Miscellaneous:—

Electric Steam Engine Governor, F. M. Garland, 460,781. Filed Feb. 26, 1891.

An arrangement by which the work of the engine is automatically regulated according to the output of the dynamo.

Electric Switch, E. W. Rice, Jr., 466,802. Filed Feb. 13, 1891.

Employs a circular track with a series of double inclines and a rotary cross-arm for connecting the contacts.

Electric Fuse or Detonator, P. Ward & E. M. Gregory, 466,856. Filed May 13, 1890.

Machine for Covering Wire, Cables, &c., and for Making Tubing and Cord, V. & J. Royle, Jr., 466,910. Filed Aug. 1, 1891.

Attachment for Phonographs, J. F. Ott, 466,922. Filed Dec. 29, 1890.

Electric Converter, G. Pfannkuche, 466,937. Filed Sept. 28, 1889.

A core made of two piles of blanks, each consisting of a long and a short arm, and coils wound around the long arm of each set of blanks.

Electric Elevator, W. Baxter, Jr., 466,973. Filed Sept. 8, 1888.

Relates to means of electrically actuating the switch of an electric motor operating an elevator.

Lightning Arrester, G. W. Spittle, 467,023. Filed Sept. 3, 1891.

Railways and Appliances:—

Wire Support for Electric Railways, W. Q. Prewitt, 466,800. Filed March 26, 1891.

An improved trolley track-hanger for electric conduits.

Electric Trolley, E. A. Sperry, 466,807. Filed June 24, 1891.

Employs a vertical helix for the erecting spring of the trolley.

Electric Motor Car, E. B. Phillips, 466,882. Filed Jan. 6, 1891.

A motor for street cars employing gearing with intermediates symmetrically disposed with reference to the driving pinion in order to balance the stress of transmission.

Electric Railway Motor, C. F. Winkler, 466,914. Filed March 26, 1891.

A motor adapted to be geared directly to the axle and in which the size of the machine is large in proportion to the size of the gear wheel on the axle with which its armature shaft engages.

Bracket for Trolley Wire Supports, etc., E. P. Russell, 466,956. Filed Sept. 11, 1891.

Rheostat, F. O. Blackwell, 467,078. Filed Jan. 12, 1891.

A rheostat adapted especially for use on electric railway cars, and in which a series of metal plates are set edgewise and cut into or out of circuit by a traveling contact.

Trolley for Electric Railways, J. Kuehnle, 466,981. Filed Sept. 5, 1891.

The trolley arm consists of a rigid lower section and a flexible upper section connected by a spring hinge.

Electrically Controlled Car Switch, B. I. Potter, 467,050. Filed Jan. 13, 1890.

Relates to means for electrically controlling the movement of a switch point from an electrically operated car.

Telegraphs:—

Printing Telegraph, J. E. Wright, 466,858. Filed Sept. 5, 1891.

Has for its object to relieve the electromagnets connected with the main line of as much load as possible.

Telephones and Apparatus:—

Nautical Signal or Sea Telephone, E. Huber & F. J. Kneuper, 467,102. Filed April 25, 1891.

An apparatus for the detection of sounds proceeding from any object in contact with water.

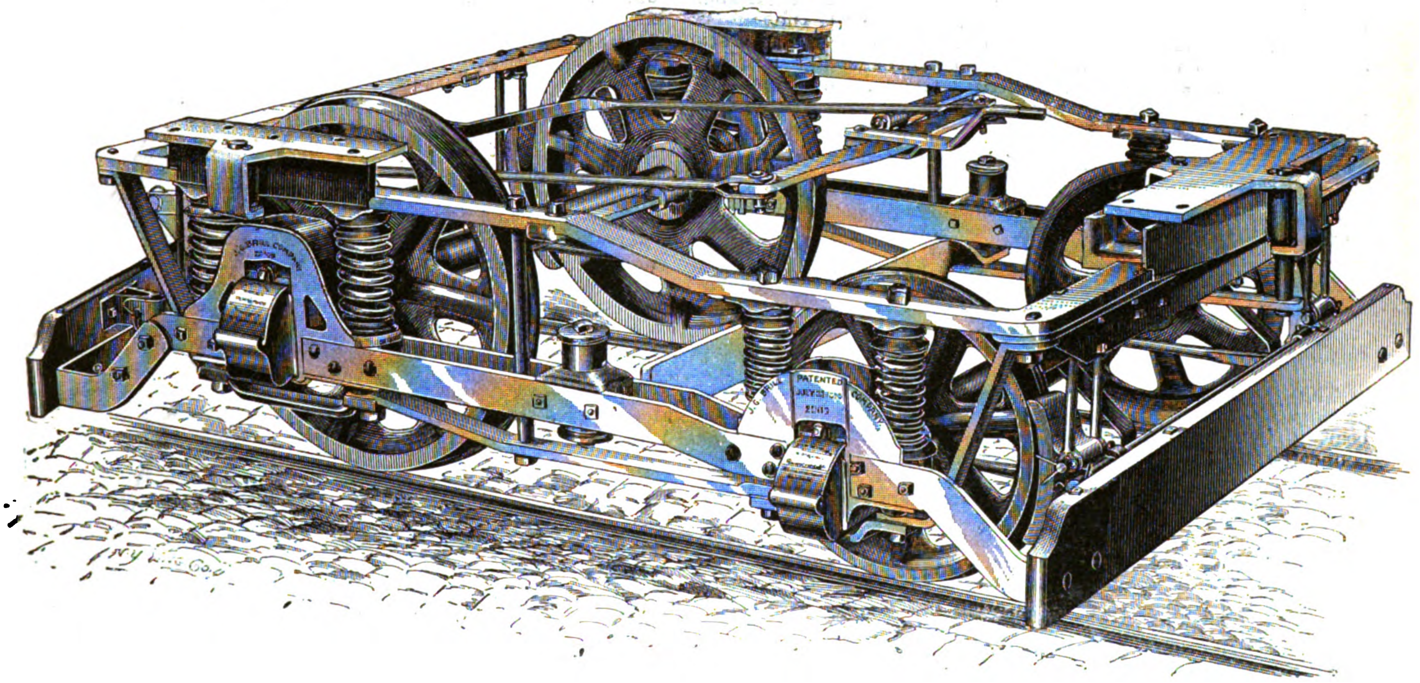
MR. JOHN A. BARRETT.

THE article on "Berliner Electrodes" in the last issue of THE ELECTRICAL ENGINEER has attracted considerable attention, as it well deserves, for a more ingenious and skillful, if not convincing, argument has rarely been advanced in support of a master patent. Our readers will be interested to know that Mr. Barrett has now established himself as an electrical expert and consulting electrical engineer, at 18 Park Row, and we have no doubt there are many who will be glad to avail themselves of his advice and long experience, as shown in his "Electrode" article.

FREDERICK WARNE & Co., N. Y., are issuing at a popular price "Electricity Up to Date for Light, Power and Traction," clearly explained, with diagrams, etc., for non-scientific readers, by John B. Verity, M. Inst. E. E. (London).

BRILL'S EUREKA MAXIMUM-TRACTION PIVOTAL TRUCK.

ONE of the most useful inventions in pivotal trucks for electric propulsion was Mr. John A. Brill's maximum-traction truck, in which many disadvantages heretofore existing were overcome and a gain made of 42½ per cent. in traction. A reduction of ten inches in the height of the car body was obtained, and thus the necessity for double steps obviated, while a shortening of wheel base was effected, and the required power reduced 30 per cent. An objectionable feature, however, was that the pivotal centre, or drawing point which comes over the axle, was in the way in removing the motor and had to be taken off. This trouble was solved by use of a movable spider. But being the pioneers in the field of electric trucks the J. G. Brill Company determined not to stop improving until they had approached more nearly to perfection, and have now produced their new model called the Eureka maximum-traction truck, shown in the accompanying illustration, in which the above-named objection has been overcome. It has no mechanical pivot and is specially adapted for the waterproof and "ironclad" types of motors which have their upper portion hinged so that they can be raised when it is necessary to get at the armature or other parts of the motor. The space above that occupied by the motor is free and clear, so that when the trap doors in the cars are raised the whole of the motor can be reached and the armature taken out, without disturbing any part of the truck. A further reduction of height of the car to the extent of one and a half inches is also obtained, and the weight of truck reduced by one hundred and fifty pounds.



BRILL'S EUREKA MAXIMUM-TRACTION PIVOTAL TRUCK.

The pivoting in this truck is accomplished by the combination of rollers on the side of the rub plates on the upper part of the truck. The drawing (draught) of the truck and car body is done from the small end of the truck, and this feature affords additional means of keeping the small wheels from climbing the rails. Since the introduction of the maximum-traction truck several hundreds of them have been sold and are in operation.

THE ROBERTSON CONDUIT SYSTEM.

A NOVEL system of conduit railway is that recently devised by Mr. A. J. Robertson, president of the Robertson Electric Railway Construction Company of this city. The conduit is made of hard burned, vitrified fire-clay, forming a continuous insulator within which the wire lies, and from which it is lifted by the trolley as the car passes. The trolley is made in two parts which separate for the purpose of lifting or dropping the wire at will.

An important feature of this system is that the conduit is laid directly upon the ties, and can be readily put in without tearing up the street.

ANNOUNCEMENT has been made that the *New York Sun* will withdraw from the Associated Press, of which it was one of the original members, and that it will hereafter take its news from the United Press.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The advertiser keeps the field of force constant around his customers.

THE "P. D. O." ELECTRIC HEAT ALARM.

CENTRAL station managers have frequently been caused an immense amount of trouble and expense, through the overheating of bearings, either on an engine, a line of shafting, or a dynamo or motor. Frequently serious accidents arise from this trouble causing the shutting down of circuits, the destruction of armatures, and an immense amount of annoyance and delay. These accidents occur often even in the best conducted stations, employing first-class engineers, where the bearings are frequently examined and the best of oil cups used. A bearing may be running perfectly cool at one moment, and yet in a few minutes time may become dangerously hot entirely unknown to the engineer in charge. It will be at once seen, therefore, that any reliable method by which the engineer could be notified, that a certain bearing in the station was getting hot, before it got to the danger point, would be of immense use, and would meet the approval of all engineers, and we therefore present to our readers a new system of electric heat alarm, the joint invention of Messrs. Pierce, Desisles, and Oliver, engineers on board the S. S. "Sappho," which is being introduced by the Electric Heat Alarm Company, of 113 Devonshire street, Boston, of which Mr. F. S. Palmer, well known to central station managers, and recently of Bangor, Me., is general manager.

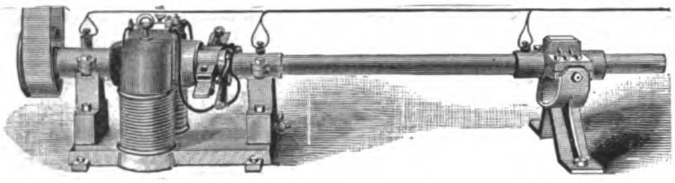


FIG. 1.—ELECTRIC ALARM FOR HOT BEARINGS.

The system consists of an automatic device which is situated on the bearing, and which closes a local battery circuit when the bearing reaches a certain temperature. This battery circuit is connected to a drop annunciator with an alarm bell, which may be situated in the engineer's office, or in any convenient place, the annunciator having a number on it for every bearing equipped with the device. As soon, therefore, as the alarm bell rings, the engineer has but to look at the annunciator, to learn at a glance, which bearing is running hot, and by quick attention, can either cool off the bearing, or at least prevent any damage from accruing. In Fig. 1 we show the application of this device to a dynamo or motor, and Fig. 2 shows how it may be applied to a line of shafting. In order to better understand the working of the automatic circuit closer, we show the device in Fig. 3, which is half as large again as the original, and Fig. 4 shows the same in section. Referring to Fig. 4, the lower half of the device is a Bessemer steel cup, $\frac{1}{32}$ inch thick and $\frac{1}{2}$ inch deep inside, into which is firmly pressed a piece of hard fibre B $\frac{5}{8}$ inch diameter, $\frac{7}{8}$ inch long, shaped as shown in the drawing, and having at the bottom $\frac{1}{16}$ inch clearance from the steel cup. The hole through the centre of the fibre is tapped at the upper end for the reception of the screw C, $\frac{7}{32}$ inch clearance, which is turned down at its lower end, the hole in the fibre being also very much smaller at the lowest end,—being bored with a number 60 drill. This screw C is connected at its upper end by means of the nut to the wire leading from one pole of the battery. A is a reservoir, which is filled with mercury, which also enters the small hole in the fibre, the top of this hole, being however $\frac{1}{16}$ inch higher than the top of the mercury chamber. At the right hand of the engraving is shown another screw, which is connected to the wire from the other pole of the battery by means of a small set screw, and forming electric contact with the mercury. The action of the device is extremely simple, depending upon the expansion of the mercury, which as the heat increases rises in the small hole in the fibre and makes contact with the lower end of the screw C, closing the circuit and sounding the alarm-bell. The amount of heat necessary to set off the alarm can be varied by moving the screw A up or down, and when its position for a certain temperature is fixed, it is firmly held in its place by a small set-screw shown in Fig. 4. The system has been in practical operation successfully for some time and can be seen in operation at the offices of the company in Boston, and as its action is sure and positive, without any complicated mechanism, it may be safely asserted that it will be largely adopted.

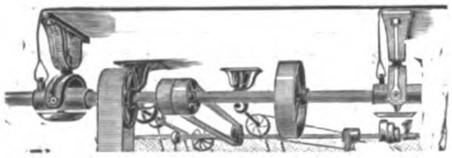
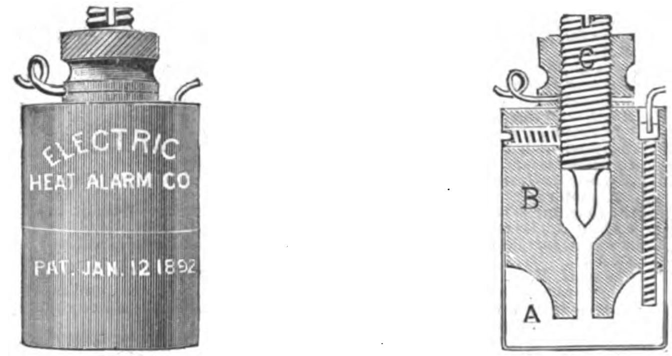


FIG. 2.—ELECTRIC ALARM FOR HOT BEARINGS.

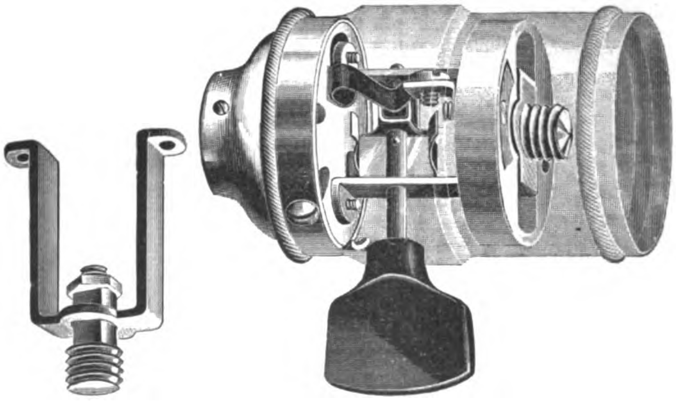


FIGS. 3 AND 4.—ELECTRIC HEAT ALARM.

THE CROWN SOCKET.

THE CROWN ELECTRIC COMPANY, of Bridgeport, Conn., have placed on the market their new socket, which embodies two new ideas.

The first of these is, a device which will keep the socket always intact. Where, as sometimes happens, the diameters of the thread of the lamp and of the contact screw are not alike, considerable force is needed to fasten the lamp, and when necessary to take the lamp down, the contact screw, being round, simply revolves in the yoke, making it necessary to break the apparatus in order to free the lamp. In the Crown socket the yoke has an oblong section and the contact screw, as it passes through the yoke, is flattened so that no matter how tightly the lamp fits, the contact screw furnishes sufficient resistance to enable the lamp to be unscrewed. The porcelain top is made to correspond to the above. This idea is shown in Fig. 1.



FIGS. 1 AND 2.—THE CROWN LAMP SOCKET.

The second point is that of the contact. The circuit is closed positively until the click is heard, and is then opened very quickly. There is no chance for an arc to be formed, and the maintaining of either a closed or open circuit is arranged by a ratchet which most effectively controls the whole thing. This is shown in Fig. 2. The contact block is made in one piece and is patented, as is also the peculiar shape of the controlling spring. The metal parts of the socket are so placed with reference to each other that there is no possibility of short circuit. The socket is made for all styles of lamps.

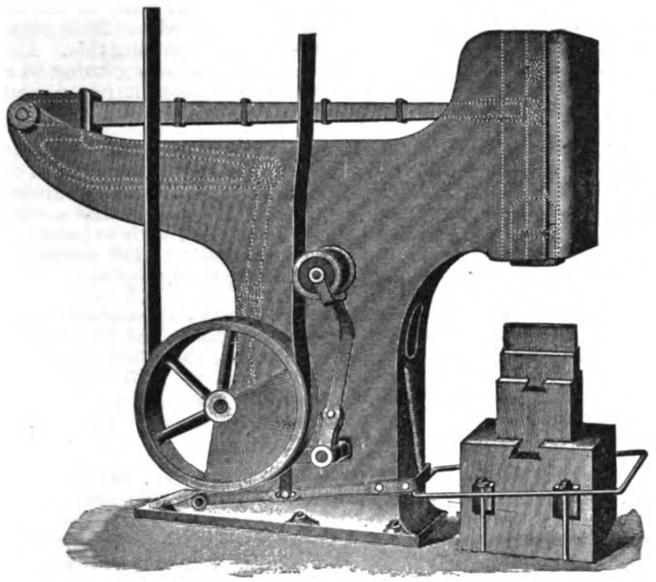
This company will shortly bring out other specialties.

DETROIT ELECTRICAL WOKKS.

NOTICE has been issued by the above-named works that Mr. Frank B. Rae is no longer in the service of the company, and that his patents under which the company has been operating in the electric railway field have been assigned to them.

THE ANDERSON POWER HAMMER.

In the manufacture of electrical apparatus, there is a general necessity for all kinds of machine tools. Not a few parts of electrical apparatus are stamped out or forged down from metal bar or rod, and any new device for forging or hammering must be of practical interest to manufacturers. In the accompanying engraving we show the Anderson power hammer which is one of the most recent types of hammers put on the market. This hammer is a rigid and effective machine made of few pieces and working on good mechanical principles. The blow is not deadened by transmitting the power to the hammer through rubber cushions or leather straps, the elasticity of the blow being obtained by the spring of the helve or handle, which is hung in such a manner as to strike effectively either on the edge or the flat side of a piece of iron, without adjusting, or in other words it will strike as an effective a blow 8 or 10 inches away from the anvil as it will close down to the anvil. The ram and guides are long and have no set screws to rattle loose, the wearing surfaces being so large that no adjustment is necessary. The helve is of hickory which can be easily and quickly replaced when after long wear it may finally give out. The anvil base is entirely separate from the hammer and is placed on a separate foundation. Between the lower die and the anvil base are two section blocks either or both of which can be removed when the hammer is to be used in upsetting a piece of metal the length of which requires it.



The Anderson Power Hammer.

These hammers are manufactured by Albert and J. M. Anderson, of 21 Hamilton street, Boston, where they can be seen in daily operation.

THE RIES ELECTRIC SPECIALTY COMPANY OF BALTIMORE, MD.

The above company, Elias E. Ries, president, were awarded the first premium and medal at the electrical exposition, recently held at Augusta, Georgia, for their well-known Regulating Socket for alternating current incandescent lamps. This Company is deserving of this honor, as their regulating socket is doing much toward making incandescent lighting universally popular. The Ries Regulating Socket is being generally adopted throughout this country and abroad, and on all sides one hears only good words for it.

"IDEAL" ENGINES.

In a handsome private hotel building known as the "St. Lawrence" near Madison Ave., built by Messrs. J. W. Weir & Son, are to be installed two 55 H. P. Ideal Self-oiling automatic engines. This contract comes through W. R. Fleming & Co. the New York Office for the Harrisburg Foundry and Machine Works, at 174 Fulton St. There are now about twenty of these engines running in New York City.

M. J. FRANCISCO & CO.

The offices of M. J. Francisco & Co. and the Rutland (Vt.) Electric Light Co. were much damaged by the fire in the Herald Building in that town on January 5. The offices, which were on the ground floor, were fitted up very handsomely only last June, and were said to be by far the handsomest in the town. In view of Mr. Francisco's business of fire insurance, there is a grim element of melancholy humor in his being hoist by his own petard, so to speak.

ELECTRIC MERCHANDISE CO.

Owing to the great satisfaction given by the Burton electric heaters which have lately been sent to foreign countries by the Electric Merchandise Co., Mr. W. R. Mason has been requested by some large capitalists in England to visit London with a view to the use of these heaters in connection with some large enterprises now under way. It may be stated that these heaters have gone to England, Germany, Switzerland and other foreign countries.

THE HAWAIIAN CABLE.

The United States fishing and surveying steamship Albatross has arrived at San Francisco from Honolulu. The steamer has been engaged in surveying a line of cable from here to the Hawaiian Islands, and reports that a practical route has been found. The first trip of the Albatross for the purpose of sounding for a cable line was made from Monterey. Seven hundred and fifty miles from San Francisco the line was taken out and 200 miles of the Monterey survey were accomplished, and then soundings were conducted to the Hawaiian Islands.

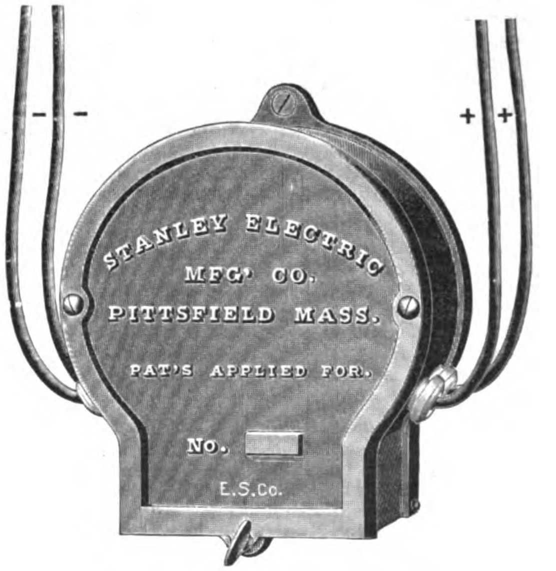
The deepest soundings were 3,000 fathoms, or three miles, and the average will show a depth of about 2,500 fathoms. At Monterey Bay, Cal., was found the best place to land the cable on this side. At Honolulu a place was found at a suburb of Honolulu named Waikiki, about four miles south of the metropolis.

THE NEW STANLEY PRIMARY FUSE BOX.

Wherever a branch is taken off the main primary wires of an alternating circuit it is very desirable to fuse it, so that if a short circuit occurs on that branch the lights supplied by it will alone be affected. If the fuse is not so used, a short circuit anywhere on the primary wires may blow the main fuses in the station, and so occasion a much more serious interruption to the service.

The unique and very safe and convenient form of fuse on the Stanley transformer having created a demand for the same style of box separate from the transformer, the Stanley Electric Manufacturing Co., of Pittsfield, Mass., are therefore now manufacturing them as shown in the accompanying illustration.

Each fuse is in a separate porcelain chamber, so that there is no danger of the current short-circuiting from one pole to the other when the fuse blows. A fuse can be replaced on a live line with perfect safety and in a very short time without the use of screw-driver or wrench. The porcelain plugs in all boxes are interchangeable, so that by having an extra plug or two no work is necessary while on the pole.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+ +
STANLEY ELECTRIC
MFG. CO.
PITTSFIELD MASS.
PAT'S APPLIED FOR.
No.
E.S.Co.

New Stanley Primary Fuse Box.

This fuse box is suitable for use on the primary circuits carrying current up to 15 amperes, and is claimed to be the safest and most convenient box made. Its interior construction is the same as the fuse box on the Stanley transformer, which is now too well known to need description here.

NEW YORK NOTES.

H. Ward Leonard & Co., as electrical contractors are installing the plants named below:

Mail & Express Building, New York City, Catherine Bradley Building, New York City, Geraldine Building, New York City, Germania Insurance Building, New York City, DuVivier & Co. Building, New York City, F. O. DuLous Building, New York Franklin Building, Brooklyn, Fifth Avenue Theatre, New York City, Columbia Theatre, Brooklyn, Graham Hotel, New York City, Mr. J. H. Inman's residence, Fifth Ave., New York City, Curtis residence, Greenwich, Conn.

Among the leading concerns for whom they are acting as Consulting Engineers are the following: Otis Elevator Co., New York City, Wm. Sellers & Co., Philadelphia, Ingersoll-Sergeant Drill Co., New York City, Eastern Electric Co., Limited, St. John, N. B., Providence Journal Co., Providence, R. I., Middletown Music Hall, Middletown, Conn., Rock Hill Electric Light Co., Rock Hill, S. C.

The Riker Electric Motor Co., Brooklyn, whose new type of slow-speed motor was recently placed on the market, are meeting with excellent success in sales of it. The following recent orders uphold their claim to an efficient and common-sense machine; For the Kingsley mill at Honduras one 60 light slow-speed dynamo of 825 revs. The Peake Piano Works one 6 h. p. elevator motor. The Leake Coffee Mill, Atlantic avenue, Brooklyn, one 2 h. p. motor; one 16 light dynamo to be coupled direct to a gas engine. At Williamsburg, N. Y., one ⅛ h. p. dental outfit; Day's brass foundry, Pearl street, N. Y., one 4 h. p. motor; four 2 h. p. motors coupled to 42 inch fan blowers for Newark, N. J.; one 16 light dynamo to the La Salle University, New York; a special dynamo for storage work for the Franklin Electric Co. N. Y. One 3 h. p. for J. Y. Johnson printing office Murray street, N. Y., and one 1 h. p. for Cobb, Danby, & Knott, Electrical Exchange Building, N. Y.

The Easton Electric Company, Brooklyn, N. Y., have just completed the successful installation of two thirty-light Easton arc dynamos, with forty Easton arc lamps, and forty Bernstein series 25 c. p. lamps on seven circuits, for the Diamond State Iron Company of Wilmington, Delaware. The extensive new mills built upon the site of those recently destroyed by fire are now brilliantly lighted throughout, and work is carried on by night as readily as by day. The iron company are as proud of their purchase from the Easton Company as they are of their new mills.

H. W. Miller, Jr., & Sons, of Philadelphia, manufacturers of asbestos pipe covering, have received a flattering letter from Messrs. Palmer & Ballard, proprietors of the Philadelphia Steam Heating Co., in which they state that after an exhaustive test of different coverings manufactured, the architects have decided to use their covering. The test of several coverings was made at the new Almshouse and this particular kind will be used throughout. This report it is claimed has had a stimulating effect on the New York business.

The Storage Battery Supply Co. have recently added an entirely new department to their business, and besides being sole agents in New York City for the Consolidated Electric Storage Co., are now bidding for the supplying stored electric power for all purposes. They report that the demand has grown so that their present supply of charged batteries is at all times exhausted. A large addition to the present plant is being made, this will enable them to supply all demands for portable lights, etc., at shortest notice.

Dr. Elisha Gray and Mr. F. W. Cushing have been in New York during the past week, busily occupied. Dr. Gray is beginning active work on the Electrical Congress and has already formulated various plans to secure publicity for the work and co-operation in it. Mr. F. W. Cushing is somewhat a man of leisure just now, having lately sold out his interest in the Central Electric Co., whose large interests have engaged his whole time for the last few years.

The Imperial Porcelain Works, of Trenton, N. J., have recently opened an office in this city. Mr. Chas. E. Chapin, well known to the electrical trade, has been appointed selling agent. The new office is located at 417 Electrical Exchange Building, 136 Liberty street. This is a desirable arrangement and will no doubt be greatly appreciated by New York buyers, as it obviates the necessity of their making a special trip to the works.

Underwood Manufacturing Co.—During the month of December one of the salesmen of the Underwood Manufacturing Co. sold to one concern an order of 40 of their cotton leather belts all of good sizes and ranging from 25 to 800 feet long for each width sold. The Engineering Equipment Co., 143 Liberty street, are their New York agents. The Chicago office is at 33 South Canal street.

Connellsville, Pa.—I learn that the Connellsville Electric Railway Co. has been organized at Connellsville to build 7 miles of single track electric road. Mr. John L. Gans, the engineer, room 10, Weihe Building, that city, is the secretary.

The Safety Insulated Wire Co., of West 29th street this city, has lately completed a large contract on the new Western Union headquarters—the finest of the kind in the country with everything else up to the same high standard. Mr. E. T. Barberie, as an old telegraph expert, being familiar with the requirements of the work, was able to meet them exactly. But Mr. Requa, the general manager of the company, is perhaps equally pleased with the contract for wiring the new United States cruiser "New York." The exacting nature of naval work is well known, and the fact that "Safety" was selected speaks volumes. Moreover it is specially happy and fitting that this wire is a product of the city after which the great new fighting ship has been named. The Safety Co. is making great strides in its manufacturing departments, and has now succeeded in serving three coats of rubber, seamless and without joint, over its insulated wire. It is stated that it is the only concern that has succeeded in doing this. Altogether the Safety Co. is active all around, and is beginning to repeat outside of New York the enormous success it has already made while limiting its efforts to this region.

Day's Kerite.—It is understood that this old and important specialty in wires and cables will hereafter be handled in the West by Mr. F. W. Cushing, who will have charge of its agency in Chicago, and will begin to push it at once in that section. Kerite is one of the things we have always had with us, and it is just as likely to be in favor 25 years hence as it was 25 years ago and is now. The selection of Mr. Cushing is admirable.

The W. S. Hill Electric Co. have certainly inaugurated a successful beginning in their New York office. The demands for Mr. Hill's well-known specialties are taxing their factory to such an extent that larger quarters are imperative. A factory in the vicinity of Boston will probably be built at once. In recent tests of large sizes of the Hill motors, the speed remained practically constant under all changes of load.

Beacon Vacuum Pump and Electric Co., Boston.—Mr. Kaliske, business manager, and Mr. Nickenson, the expert of the Beacon Vacuum Pump and Electric Co., have been in New York during the past day or two, and it is not unreasonable to expect that company to make a more prominent appearance than heretofore in New York at an early day.

The Engineering Equipment Co. will shortly introduce to the trade a special new style of hard fibre pipe for use in underground work. This pipe, it is claimed, will decrease the cost of underground work about 25 per cent. It is durable and a perfect insulator.

The Edison Co., and the underwriters are not quite agreed as to the safety of the practice of "grounding the neutral." Under the rule of the Board here, against grounded wires, no building can be given insurance in which such a method is resorted to.

Mr. J. W. Mackay is making a strong fight in a writ brought against him for $75,000 by E. S. Stokes, the litigation being based on claims due to old dealings in the Postal and other telegraph properties.

Mr. Francis G. Daniell, late of the Short Electric Railway Co., has become connected with the firm of Barry & McTighe, of 52 and 54 William street, this city, as electrical engineer.

Mr. M. E. Baird, well known throughout the country as the general representative of the Eddy Electric Manufacturing Co., spent a few days in the city last week.

Mr. W. O. Cook, inventor and patentee of the Cook portable switch or car replacer, for replacing derailed electric and horse cars, is in the city.

Mr. Wm. Bracken, president of the Consolidated Electric Storage Co., is absent from the city on a business trip through the West.

Burlington, N. J.—The president of the Board of Trade is ready to receive proposals for lighting the streets by electricity.

PHILADELPHIA NOTES.

Alfred F. Moore, the manufacturer of insulated electric wire and cables, gives notice that his house has withdrawn its agency in Chicago, which has until recently been controlled by Mr. G. A. Harmount, of the Monitor Electric Co., Chicago. All communications or orders should now be addressed direct to Mr. Moore at the office and works at 200 North Third street, Philadelphia.

Mr. William N. Famous, formerly with Vallee Bros. & Co., has accepted a position as traveling salesman for the Pennsylvania Electric Engineering Co.

Mr. Norman Marshall has resigned from the position of treasurer of the Star Electric Co., and is succeeded by Mr Alexander Hamilton.

NEW ENGLAND NOTES.

The Electric Mutual Insurance Company, of Boston, is deceased, after a life of about 18 months. The outstanding business of the company has all been reinsured by the Home Insurance Company, of New York, one of the largest companies of its kind in the country, having assets of about $10,000.000. The net premium receipts of the Electric Mutual during 1890 aggregated $26,895, and its risks in force at the end of that year amounted to nearly $2,900,000. There is, however, now in progress the formation of a syndicate, who will write electric risks, composed of the Home Company and six others. A more complete system of inspection will be made, and the local agencies of the companies will make out the policies, tariff rates being adhered to. Mr. Barton, for the present, will conduct the management of the syndicate from the office of the Electric Mutual Company, in Boston, but will probably later move to New York. This method will effectually get rid of the difficulty of legal entrance into any of the States and will broaden out indefinitely the field of work.

A Remarkable Test.—Fifteen months ago, the Gould & Watson Co. caused a moulded mica bell, of the old Sprague pattern, to be put under water, where it remained until a few days since. The object sought was a demonstration of their insulation regarding its waterproof qualities. At the end of this long immersion the bell was connected to a 220-volt current, a wire being fastened to each brass nut. A low-reading Weston voltmeter showed no leakage. A delicate galvanometer being then attached, showed a deflection of the needle, while the bell was still wet. At the end of half an hour, the same current gave no deflection of the galvanometer, the surface water having by that time evaporated. So severe a test as this is of course unnecessary as a demonstration, but it was with much gratification that the firm learned that moulded mica is indeed waterproof, after 15 months under water.

The Benedict and Burnham Manufacturing Company, of Waterbury, Conn., are achieving great success with their new "Benedict" wires and cables, and they are evidently manufacturing a superior wire which fills a felt want. The "Benedict" wire is very substantially made, and every fibre of its texture is thoroughly saturated with their special compound, making a wire of unusually high insulation, and of great toughness and capability of resisting abrasion. Their Boston office has recently moved into more convenient and commodious quarters at 26 Oliver street, only a short distance from their old store, and will continue to carry a full line of all their high-class goods. All inquiries will be courteously attended to by Mr. Rugg, their well-known Eastern representative.

The Gould Packing Company, of East Cambridge, the original and only manufacturers of the genuine Gould's packing, have done a remarkably good business during the past year and are in receipt of many very flattering testimonials as to the solid worth of their goods. They have recently received a number of large orders for government work and are also supplying a large number of electric light and power stations with their packing for steam engines. Other packings similar in appearance to the Gould packing are sold, but there is none genuine or similar in quality except that sold by the Gould Packing Company, who furnish nothing but the best quality which is always the same and always up to standard.

The New England Printing Telegraph Company are now ready to do a regular telegraph business, between Boston, Providence, Woonsocket and Danielsonville, over their own lines which have just been completed into the city. The offices of the company are situated at Nos. 99–101 Milk street, Boston, No. 19 South Water street, Providence, R. I., office *Woonsocket Reporter*, Woonsocket, R. I., and Quinnebaug Store, Danielsonville, Conn.; where messages will be received for transmission, and messages received at these offices will be delivered throughout the cities by messengers. The tariff rate will be 15 cents for 10 words, and one cent for each additional word, address and signature free.

The Hubbell Portable Electic Lamp and Power Company.—In a recent issue, it was stated erroneously that the Consolidated Electric Motor Company had secured control of the Hubbell battery. This was a mistake, as it appears that the above company is entirely distinct from the Consolidated Motor Company and will soon open offices of its own at 116 Bedford street, Boston. It is proposed to move the whole manufacturing plant from New York to Boston, and manufacture hereafter in this city.

The New England Screw Company, of Brockton, Mass., will shortly move into a new factory in Boston, and there continue the manufacture of all kinds of rolled thread screws for the electrical trade. Mr. C. H. Mavers is president, and Mr. T. P. Swift, treasurer, and they will push the business to even larger proportions than before.

Mr. P. H. Alexander, of New York, was in Boston last week, enlarging on his favorite topic of A. B. C. He is now after the rest of the alphabet.

The Revere Rubber Company, of Boston, are pushing the sales of the "Elliott" trolley line insulator, and the "Elliott" pull-off, in addition to their regular line of hard rubber insulating goods. The rubber which they use for the Elliott insulators is of a special nature, being extremely strong, of high insulating property, and unbreakable. Mr. C. B. Elliott is the manager of the electrical department, and will be glad to afford any information regarding these goods.

Mr. J. M. Orford, of Bridgeport, does not often come as far East as Boston. He prefers the society of New York, and does not yet appreciate the tone of the Hub. When seen lately, however, in this city he appeared to be enjoying himself as well as looking after the interest of the Union socket—and rumor has it that he was heard to remark in a moment of forgetfulness, "Of some things only the best are worth having."

The Tropical American Telephone Company, Limited, has secured the agency of the Viaduct Manufacturing Company, of Baltimore, and will hereafter keep a full line of all goods at their new headquarters at 95 Broad street, New York. Mr. Frank Harrington, as before, will look after the interests of the company in New York, and Mr. Howard, the general manager, will divide his time between New York and Boston.

The H. E. Swift Manufacturing Company, of Boston, continue to do a very large business in push-buttons, annunciators, bells, lamp bases, and general electric fittings. Their factory is at present driven to its utmost capacity, and their goods are meeting with general approval by the trade. Mr. T. P. Swift has recently been elected as secretary and treasurer of the company.

Mr. George Cutter, of Chicago, was circulating 'round among his friends in Boston, this week, and talking of "big things" to come in the Windy City in '93. The latest about Mr. Cutter's street hoods is that they are an '*owling* success.

Mr. E. K. Gilman, of Chicago, favored Boston with a fleeting visit, and then hied himself away to more congenial latitudes.

Mr. Norman Marshall, of Philadelphia, was in Boston this week looking after the interests of the Star Electrix Company.

CINCINNATI NOTES.

The Le Boiteau Fan Motor Co., are busily engaged in manufacturing a large supply of their universal revolving fan motors for the large demands which will be made on them shortly, as these fans fill a long felt want in distributing a breeze not only in one direction as with the old fan motors, but in all directions to all parts of a room.

The Card Electric Motor & Dynamo Co., Second and Plum streets, Cincinnati, are installing a number of very fine motor plants which are giving eminent satisfaction, and Mr. Wilshire, president of the company, reports that every sale leads to several more, as parties using the motors are quick to recommend them to their friends.

The Electric Supply & Contracting Co., Nevada Building Cincinnati, are doing a large amount of repair work for electric street railways, rewinding armatures, etc., and have received a number of the most flattering testimonials regarding the reasonable price and excellence of their work.

The Lunkeheimer Brass Manufacturing Co. still continue to flood the market with their brass specialties which are known and used by almost all power users.

Jones Bros., Cincinnati continue to furnish general electrical supplies for all kinds of electrical work and are doing a good and prosperous business.

NEW YORK SUBWAYS.

The year's work under the Board of Electrical Control comprises the removal of 5,224 poles and 7,152¼ miles of wire and the construction of 114 miles of subways. The capacity of this subway work is as follows: 47 miles for electric light service, 721 miles for telephone and telegraph service, and 121 miles for Edison light service. There are now in use in the city 1,420 miles of subways, divided as follows: Electric light subways. 578 miles; telephone and telegraph subways, 721 miles, and Edison subways, 121 miles.

WIRES IN NEW YORK.

Mayor Grant in his annual message points out that only one death through overhead wires occurred in New York City in 1891, and that that was due to the fall of a telegraph pole. There are now 143 high tension circuits, making 528 miles of electric light conductors underground, and 383 miles of low-tension lighting in the Edison circuits. Mayor Grant recommends the establishment of a central municipal telegraph and telephone exchange.

WESTERN NOTES.

THE ELECTRIC APPLIANCE COMPANY are meeting with large success in the introduction of their latest specialty, the "Standard lamp." To remove any erroneous impression that may be abroad, the company desires to state that this is a new lamp and manufactured by an entirely new company having in its employ some of the most experienced lamp men in the country. They are putting out an elegant lamp in every respect and one that is a credit to any factory. Great claims for life, efficiency and non-discoloration are made on every side by those who have tested and adopted the lamp. The Electric Appliance Company also report large sales of Paranite wire and its hearty recommendation by all users.

MR. W. L. ADAMS.—The above-named gentleman, who is very well known in electrical circles, has just been elected secretary and treasurer of the Electric Merchandise Co., with which concern he has been connected as traveling representative for some time past. Mr. Adams is a keen business man, bright and energetic, and is to be congratulated on his advancement to so prominent a position in a company which has achieved so extended a reputation as exclusive dealers in electric street railway supplies.

THE ELECTRIC MERCHANDISE COMPANY continues to fill orders for Burton electric heaters. The merits of this device are widely known, and worn-out stoves are quite generally being replaced by them. Orders have been received from several Western mining companies for use in their plants. The diploma for efficiency has recently been awarded the Burton electric heaters by the Canadian Electrical Exposition committee.

THE DETROIT ELECTRICAL WORKS have opened a Chicago office at No. 431 Rookery, in charge of Mr. L. E. Myers who is an old electric railway man and well known in the business, having been associated with the Sprague and Edison Companies several years. There is no doubt that, managed by so experienced and genial a gentleman as Mr. Meyers the Chicago office will be a success from the start.

MR. H. K. GILMAN, vice-president and general manager of the Great Western Electrical Supply Co. of Chicago, has returned from an exceedingly prosperous business trip East on which he secured some very large orders. He reports the outlook for a very large business as highly encouraging, and states that his company are keeping well abreast of the times in the number and magnitude of their shipments.

MR. WM. HOOD is installing a number of Mosher arc lamps for incandescent circuits in different parts of the city. The lamps are giving good satisfaction, and burn with a clear, steady white light and with an economical consumption of current. Mr. Hood is also receiving a great many orders for the Jewel incandescent lamps, which seem to be becoming great favorites all over the country.

THE D. M. STEWARD MFG. CO., of Chattanooga, Tenn., continues to note a marked improvement in business, and being already very active finds that it is beginning to run behind its orders. This is a very gratifying sign of better times in the light and power industry. Lava insulators long since became one of the staples of the trade, by which general conditions may be gauged.

CENTRAL THOMSON-HOUSTON.—The regular annual meeting of the Central Thomson-Houston Company was held at the office at 264 W. Fourth street, Cincinnati, Jan. 4th. The officers for 1892 are: Franklin Alter, president; H. P. Piper, vice-president; Paul T. Brady, treasurer and general manager; W. F. Hayes, assistant treasurer; A. B. Champion, secretary.

THE MATHER ELECTRIC CO., which is represented by Mr. Julius Andrae, have just closed one of the largest motor deals in the country through their Mr. F. A. Baux, their Chicago agent. The plant comprises a 350 h. p. generator, some 23 motors and one 800 incandescent light machine. The plant is to be installed in the Blatz brewery.

THE DORMAN DYNAMO CO., of Chicago, was incorporated December 17. It is rumored that among other factories the late Belding Motor Company is being negotiated for. It is the intention to build dynamos of all descriptions, from the smallest sizes to 2,000 h. p. Mr. Dorman still remains electrician to the Standard Electric Co.

FRASER & CHALMERS, of Chicago, have presented the Western office of THE ELECTRICAL ENGINEER with an exceedingly handsome, framed engraving of the Masonic Temple Building, Chicago, for which this well-known firm have furnished the boilers, engines and machinery, the total weight of which is stated as 325 tons.

THE ILLINOIS ELECTRIC MATERIAL CO. are placing on the market a new flexible duct for drawing in wires for interior lighting, which is meeting with considerable success.

MR. F. W. CUSHING has resigned the secretaryship of the Central Electric Co. and will probably devote his time to marketing the telautograph in which he is interested.

MR. R. MORRISON, engineer of the Winona Lumber Co., Winona, Minn., has made the show window of Morrison & Johnson in that city very attractive by fitting up a small motor with a revolving incandescent lamp, so that a ball of fire appears to be flying around incessantly before the bewildered spectator.

PROF. J. P. BARRETT has returned from his recent visit to New York, as hale and hearty as ever. The Gothamites endeavored to induce the professor to remain with them, but he thinks Chicago a pretty good place to live in and no amount of persuasion could induce him to desert the "Garden City."

BLISS & SODEN, of Chicago, well-known consulting electrical engineers, are kept quite busy attending to various expert testing work and drawing specifications for construction work. These gentlemen are well known among the electrical fraternity for their ability in consulting electrical engineering work.

THE ILLINOIS ELECTRIC MATERIAL CO. have had quite a run during the past week on their various novelties. A miniature motor operated by a battery contained in the base and used to drive all kinds of cardboard figures has been a marked attraction and sold faster than they could supply the demand.

MR. J. R. MARKLE, one of the veterans of the electrical business in the West, was a caller at the Western office of THE ELECTRICAL ENGINEER last week. He is now devoting the principal portion of his time to consolidation of electric lighting, railway and gas company interests.

THE WESTERN ELECTRICAL SUPPLY CO., 619 Locust street, St. Louis, are doing a flourishing business. Amongst recent large orders shipped is one to the Lincoln (Ill.) Water, Light and Power Co. of 20 miles of K. K. wire and full equipments for their arc and incandescent circuits.

MR. J. F. KESTER, of the Kester Electric Co., manufacturers of automatic incandescent dynamos, automatic motors, electric supplies, etc., Terre Haute, Ind., was a welcome visitor to Chicago last week, and reported that he was doing a good business for his company.

MR. GEORGE CUTTER the electrical specialist of Chicago, has gone East to arrange details regarding the recent million-foot order of Simplex wire with the Simplex Co. of Boston. He also has the felicity of handing them another similar order for the same amount.

THE CENTRAL ELECTRIC CO. report since taking the agency for the Interior Conduit & Insulation Company, that they have secured an order for 50,000 feet of one size tube. It certainly can be said that they have started in well.

THE ILLINOIS ELECTRIC MATERIAL CO. have recently obtained the Western agency for the Draper oiler, Redding watchman's clock and fire gongs, and Tregoning tell-tale for use on circuits to notify station men when a line breaks.

THE SHORT ELECTRIC RAILWAY CO., of Cleveland, have recently sold an equipment of 120 gearless motors to the Minneapolis Street Railway Co., and also twelve to the Grand Rapids Street Railway Co.

THE GREAT WESTERN ELECTRIC SUPPLY CO. are receiving large orders from various parts of the country for general electrical supplies for lighting, power and other electrical work.

MR. D. C. SIMS has been appointed manager of the Western Union Telegraph Co., at Atlanta, Ga. He will be succeeded as manager of the Mobile office by Mr. P. K. Garner.

THE KNAPP ELECTRICAL WORKS are catching their usual share of business and are shipping large numbers of Perkins lamps and some good orders for safety wire.

MR. L. W. MOYER has accepted a position as city salesman with the Knapp Electrical Works.

JULIUS ANDRAE has sold a 250 light incandescent Mather machine for Krans & Co.

CLAY, PEPPER & REGISTER DISSOLUTION.

THE firm of Clay, Pepper & Register has been dissolved by mutual consent. The business will be carried on as heretofore by the remaining partners under the firm name of Pepper & Register.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

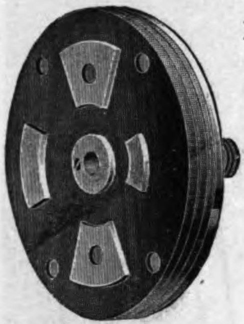
THE
Electrical Engineer.

VOL. XIII. FEBRUARY 3, 1892. No. 196.

THE JOHNSON SWITCH.

BY

Edw. H. Johnson



NLY considered as a bit of mechanism, this switch is almost identical with the ordinary mechanic's vise, differing therefrom simply in the means provided for automatically shutting the jaws when they have been sufficiently opened by the hand to release the outer jaw from the restraining stops. The stops employed are at one and the same time the contacts and the ratchet shaped stops which determine and limit each movement of the switch.

The power employed for effecting the automatic shutting of the vice is a helical wire spring put under tension by each throw of the switch handle and operative to throw the released jaw back to its normal position with such force as to effect a positive wedging of the jaws, alternately locking the circuit closed and locking it open. The releasing of the lock is effected as in an ordinary vise by simply turning the screw-threaded handle until the free jaw is withdrawn sufficiently to permit it to move over the stop [contact] faces.

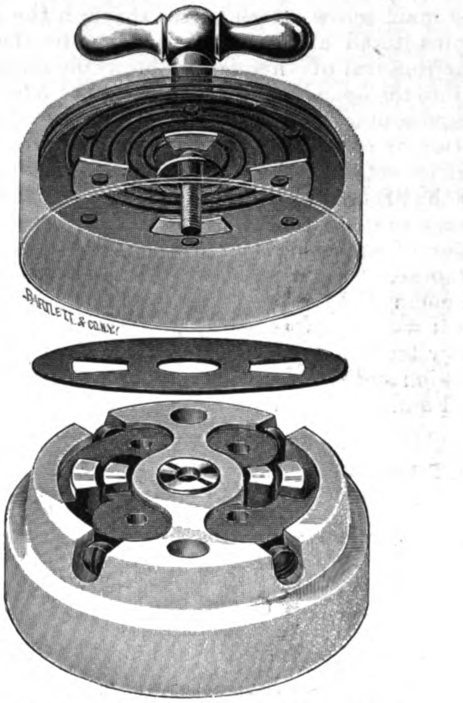
Considered as an electric circuit-controlling device, this switch employs a principle not hitherto made available in snap switches, that is, the substitution of perfectly rigid contacts for contacts dependent upon spring pressure, and the wedging of these rigid contacts between two immovable jaws instead of between yielding springs. The mechanical arrangement thus established is precisely the same as would result from cutting a wire in two, flattening the severed ends, placing them the one upon the other and then wedging them tightly together in a bench vise. Of course it can be seen at a glance that electrically considered we have contacts which under heat must, by natural expansion, be more perfectly united and hence effect a reduction of the heating, thus practically removing the contact surfaces as factors of carrying capacity and raising the capacity of the switch to the actual safe-carrying capacity of the metal employed in the terminals; whereas in all other snap switches, spring pressure being the only opposing factor, the effect of contact heating is diametrically opposite; the heat is communicated to the contact springs, which, in consequence, lose their temper and therefore their pressure thus lessening the contact surface, increasing the heat and effecting the quick destruction of the switch. The carrying limits of all such switches is thereby confined to the safe non-heating limit of the contact surfaces, and even this is an indeterminable because variable quantity, it being subject to the omnipresent element of surface corrosion.

The "breaking" capacity is so high as to render the switch practically independent of any electromotive force ordinarily employed in multiple systems of distribution, whether for light or power. The reason for this is twofold:

1st. The gun-trigger quickness and positiveness of the break, and

2d. The fact that the arc traverses a path twice the length of the switch movement. The means by which this result is accomplished are simple, and are shown on the face of the contact terminals.

A test of the 100 ampere switch on a 500 volt railway circuit showed that the switch would break a current of 100 amperes and 500 volts. Each wire as will be seen in Fig. 1, is fitted with a terminal and these are arranged in two groups or pairs with their contact surfaces parallel with each other; these surfaces are slightly beveled, presenting somewhat of a ratchet form. It is obvious that if each pair of these parallel pieces are bridged by holding a separate metal plate across their faces, the circuit will be closed; these separate plates are carried upon the inner surface of the movable jaw [see Fig. 2.] They are so held and shaped as to give them a slight rocking motion to the end that they may seat themselves with equal firmness upon each of the lower terminals. The smaller plates in Fig. 2 are merely stops so arranged as to seat upon but a single one of each pair of the terminals thus failing to bridge or unite the pairs and consequently leaving the circuit locked open. Fig. 3 is merely an insulating shield. It will now be apparent that if the two plates are united by means of the screw which passes through the handle, or main vise screw, [Fig. 2] and the upper plate is turned on


BARTLETT & CO. N.Y.

FIGS. 1, 2 AND 3.—THE JOHNSON SWITCH.

its operating screw, the two plates will wedge together and since the contact surfaces are slightly raised above the general surface that this wedging will take place on the contact faces. Whether the first action will be to effect a closing of the circuit by bridging the terminals with the broad plates, or to leave the circuit open by wedging the non-bridging terminals, depends simply upon the chance relation of the parts when put together. In either event it is evident that whether the switch is open or closed it has attained a dead stop and no amount of effort to turn it beyond this point will avail. But now if instead of turning the plate itself, the handle be turned, we will have the upper plate gradually withdrawn until the jaws are wide enough apart to permit the contact plates to pass over the highest portion of the beveled terminal faces; the upper plate is thus freed to rotate with the screw and does so with the vigor and snap of a gun trigger by virtue of the tension spring connecting it with the handle and located on its top surface away from the contact surfaces of the switch. The effect of this quick rotation of the plate on its screw is of course to run it down again on the screw to its wedging position and consequently to stop it there with the switch open or closed as the case may be. Each alternate movement always in the same direction thus effects an alternating opening and closing of the circuit.

The entire arrangement of the switch is happy in that each and every part is readily accessible from the face of the switch, and they are all exposed by the removal of a single main screw which passes through the switch handle and pins it and all the working parts to the base plate; by the removal of this screw the whole switch movement falls into the open hand, thus leaving the base plate with its terminal contacts perfectly unobstructed, and rendering the insertion or removal of the wires a most convenient matter.

The inventor of this switch has had for more than five years the firm conviction that the use of spring contacts was contrary to good practice, and so long ago as 1886 made a number of experimental switches in which he sought to incorporate the new principle. Press of other duties, however, compelled the laying aside of the work until recently when it was again taken up and satisfactorily concluded. He now tenders this device to the electrical engineering profession and the electrical industry in the firm belief that a good and valuable service has been rendered.

ELECTRIC DRILL OF THE BERLIN ALLGEMEINE ELEKTRICITAETS GESELLSCHAFT.[1]

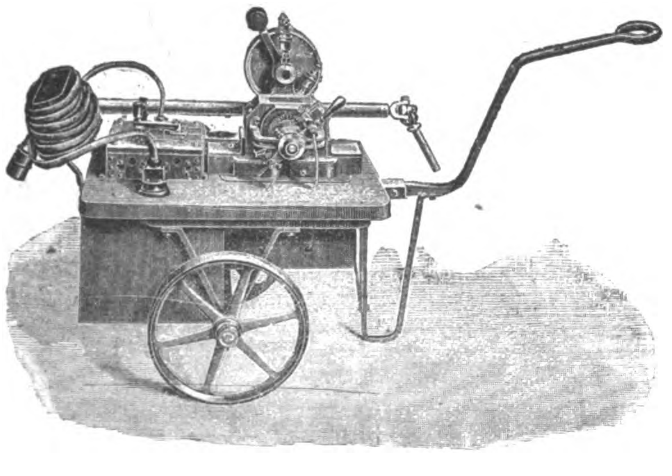


Fig. 1.—Portable Electric Drill.

In order to show the direct applicability of electric motive power to the driving of the tools in machine shops, the Allgemeine Elektricitäts Gesellschaft in Berlin some time ago equipped its entire establishment with electric motors which drive all the shafting, the current being obtained from the central station. One of the latest applications of portable electric tools introduced by them is that exhibited in the engraving, Fig. 1, which shows a portable drill which has already proved of great value in the workshops. The drill is mounted on a platform which also carries the starting box. The power of the motor is transferred to the drill through the medium of reducing gears which can be thrown in or out by means of a lever. The drill is attached to the driving-shaft by means of a universal telescope joint so that the motor and carriage need not be disturbed when the position of the drill is changed. In order to vary the speed of rotation of the drill to correspond to different sizes of holes, the drill spindle is provided with a reduction gear, so that the speed can be reduced from 195, the maximum, to 65 revolutions per minute, at which speed holes 1¼ inch in diameter can be bored. Our illustration, Fig. 2, shows a view in the shops of the company with the machine in operation drilling holes in an engine frame, and also the overhead traveling crane operated by electric motor.

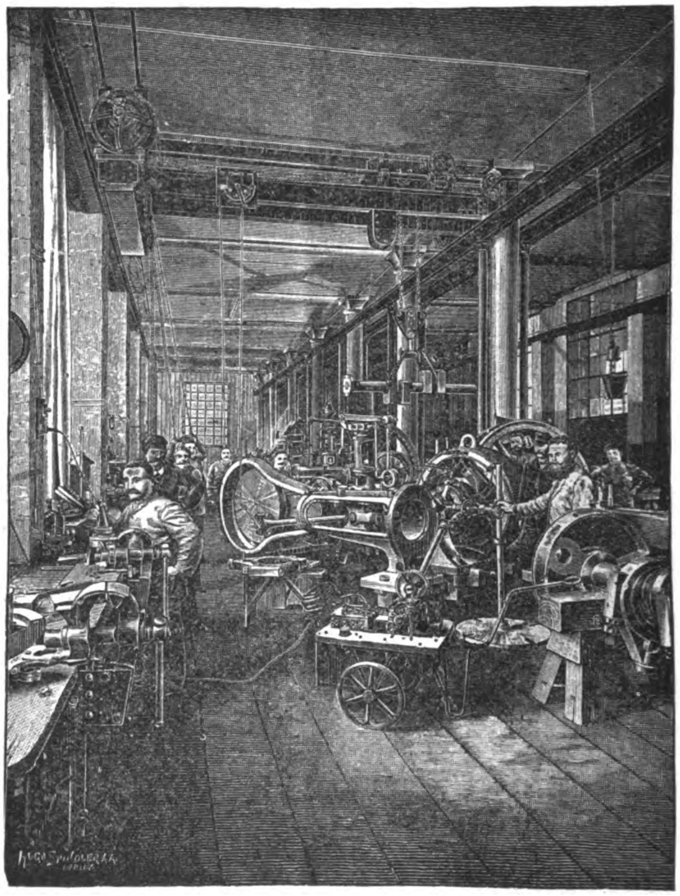


Fig. 2.—Portable Electric Drill at Work.

"L'ELECTRICIEN."

Our Paris contemporary, *L'Electricien*, announces that from January 1, it will be under the management of an editorial committee consisting of Prof. Monnier (École Centrale des Arts et Manufactures), Prof. Éric Gérard (Institut Électrotechnique Montefiore), M. Félix Lucas, M. Emile Dieudonné, M. Eugène Meylan, M. Montpellier (founder of the *Rèvue Internationale de l'Electricité*). The chief object of the appointment of a committee is to secure absolute impartiality.

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[1] Elektrotechnische Rundschau.

AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—III.

BY

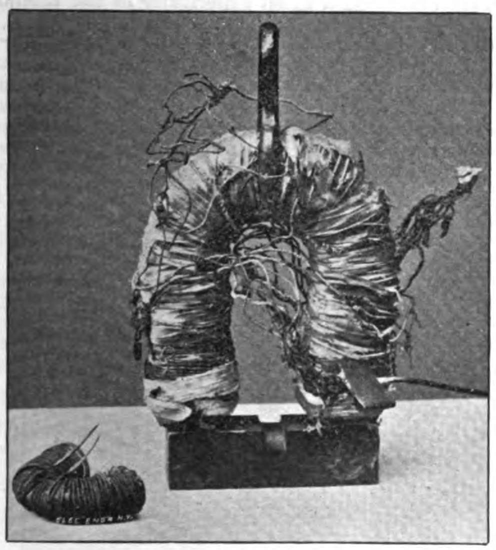
Mary A. Henry

In every well-ordered library stand the volumes of Silliman's *Journal of Science*, the chief repository of the labors of the pioneers, the scientific investigators of our earlier years. If it has been pleasant to dwell in our own words upon Henry's experiment which answered the great question: Can Magnetism produce Electricity? let us now allow him to tell his own story; let us find in the *Journal* the paper we saw him hurriedly preparing for its pages in those last days of June, after reading the brief notice which told him of Faraday's success. It is dated July, 1832. We give it entire, breaking the thread of the narrative here and there for comment:

ON THE PRODUCTION OF CURRENTS AND SPARKS OF ELECTRICITY FROM MAGNETISM.[15]

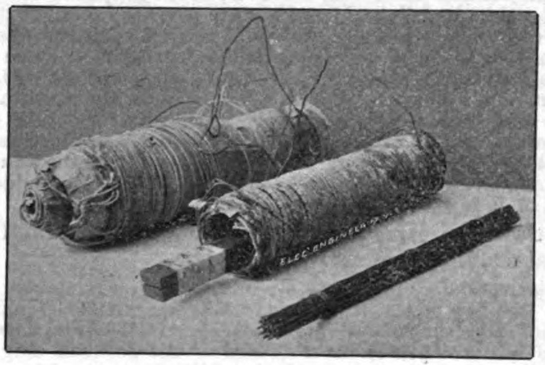
Although the discoveries of Oersted, Arago, Faraday and others, have placed the intimate connection of electricity and magnetism in a most striking point of view, and although the theory of Ampère has referred all the phenomena of both these departments of science to the same general laws, yet until lately one thing remained to be proved by experiment, in order more fully to establish their identity; namely, the possibility of producing electrical effects from magnetism. It is well known that surprising magnetic results can readily be obtained from electricity, and at first sight it might be supposed that electrical effects could with equal facility be produced from magnetism; but such has not been found to be the case, for although the experiment has often been attempted, it has nearly as often failed.

Henry's discovery was no accidental stumbling upon a fact. He believed with all his heart that electricity could produce magnetism before he put the matter to experimental test. From the very beginning of his researches he had the subject in view.



ELECTROMAGNET WITH WHICH THE DISCOVERY OF MAGNETO-ELECTRIC INDUCTION WAS MADE BY HENRY; NOW IN THE CABINET OF THE COLLEGE OF NEW JERSEY.

It early occurred to me, that if galvanic magnets on my plan were substituted for ordinary magnets, in researches of this kind, more success might be expected. Besides their great power, these magnets possess other properties, which render them important instruments in the hands of the experimenter; their polarity can be instantaneously reversed, and their magnetism suddenly destroyed or called into full action, according as the occasion may require. With this view, I commenced, last August,[16] the construction of a much larger galvanic magnet than, to my knowledge, had before been attempted, and also made preparations for a series of experiments with it on a large scale, in reference to the production of electricity from magnetism. *I was however at that time accidentally interrupted* in the prosecution of these experiments, *and have not been able since to resume them until within the last few weeks*,[17] and then on a much smaller scale than was at first intended. In the meantime, it has been announced in the 117th number of the *Library of Useful Knowledge*, that the result so much sought after has at length been found by Mr. Faraday of the Royal Institution. It states that he has established the general fact, that when a piece of metal is moved in any direction, in front of a magnetic pole, electrical currents are developed in the metal, which pass in a direction at right angles to its own motion, and also that the application of this principle affords a complete and satisfactory explanation of the phenomena of magnetic rotation. No detail is given of the experiments, and it is somewhat surprising that results so interesting, and which certainly form a new era in the history of electricity and magnetism, should not have been more fully described before this time in some of the English publications; the only mention I have found of them is the following short account from the *Annals of Philosophy* for April under the head of "Proceedings of the Royal Institution."



APPARATUS MADE BY HENRY, WITH WHICH HE REPEATED THE EXPERIMENT OF FARADAY. NOW IN THE CABINET OF THE COLLEGE OF NEW JERSEY.

> Feb. 17, Mr. Faraday gave an account of the first two parts of his researches in electricity; namely, volta-electric induction and magneto-electric induction. If two wires, A and B, be placed side by side, but not in contact, and a voltaic current be passed through A, there is instantly a current produced by induction in B, in the opposite direction. Although the principal current in A be continued, still the secondary current in B is not found to accompany it, for it ceases after the first moment, but when the principal current is stopped then there is a second current produced in B, in the opposite direction to that of the first produced by the inductive action, or in the same direction as that of the principal current.
>
> If a wire connected at both extremities with a galvanometer, be coiled in the form of a helix around a magnet, no current of electricity takes place in it. This is an experiment which has been made by various persons hundreds of times, in the hope of evolving electricity from magnetism, and, as in other cases in which the wishes of the experimenter and the facts are opposed to each other, has given rise to very conflicting conclusions. But if the magnet be withdrawn from or introduced into such a helix, a current of electricity is produced *whilst the magnet is in motion*, and is rendered evident by the deflection of the galvanometer. If a single wire be passed by a magnetic pole, a current of electricity is induced through it which can be rendered sensible.[18]

So far, Henry's paper is introductory. It now gives two series of experiments, *the one made before, the other after* seeing the brief account of Faraday's result. In the first series we find the experiment we have sketched, and if made before April, 1832, the date of the notice, then, before August, 1831, when Henry's experiments stopped.

Before having any knowledge of the method given in the above account, I had succeeded in producing electrical effects in the following manner, which differs from that employed by Mr. Faraday, and which appears to me to develop some new and interesting facts. A piece of copper wire, about 30 feet long and covered with elastic varnish, was closely coiled around the middle of the soft iron armature of the galvanic magnet, described in vol. xix, of the *American Journal of Science*, and which, when excited, will readily sustain between 600 and 700 pounds. The wire was wound upon itself so as to occupy only about one inch of the armature, which is seven inches in all. The armature, thus furnished with the wire, was placed in its proper position across the ends of the galvanic magnet, and there fastened so that no motion could take place. The two projecting ends of the helix were dipped into two cups of mercury, and there connected with a distant galvanometer by means of two copper wires, each about 40 feet long. This arrangement being completed, I stationed myself near the galvanometer and directed an assistant at a given word to immerse suddenly, in a vessel of dilute acid, the galvanic battery attached to the magnet. At the instant of immersion, the north end of the needle was deflected 30 degrees to the west, indicating a current of electricity from the helix surrounding the armature. The effect, however, appeared only as a single impulse, for the needle, after a few oscillations, resumed its former undisturbed position in the magnetic meridian, although the galvanic action of the battery, and consequently the magnetic power, was still continued. I was, however, much surprised to see the needle suddenly deflected from a state of rest to about 20 degrees to the east, or in a contrary direction, when the battery was withdrawn from the acid, and again deflected to the west when it was reimmersed. This operation was repeated many times in succession, and uniformly with the same result, the armature the whole time remaining immovably attached to the poles of the magnet, no motion being required to produce the effect, as it appeared to take place only in consequence of the instantaneous development of the magnetic action in one, and the sudden cessation of it in the other.

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[15] From Silliman's *American Journal of Science*; July, 1832; vol. xxii, pp. 403-408.

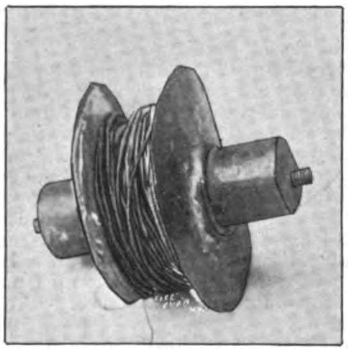
[16] That is, August, 1831, since the paper was published July 1, 1832. M. A. H.

[17] The last two weeks in June (see latter part of the paper) an interval of ten weeks between the cessation and resumption of the experiment. M. A. H.

[18] *Phil. Mag. and Annals of Philosophy*; April 1832: vol. xi, p. 300.

Notice here Henry's instant recognition of the fundamental conditions of the phenomenon.

This experiment illustrates most strikingly the reciprocal action of the two principles of electricity and magnetism, if indeed it does not establish their absolute identity. In the first place, magnetism is developed in the soft iron of the galvanic magnet by the action of the currents of electricity from the battery, and secondly, the armature, rendered magnetic by contact with the poles of the magnet, induces in its turn currents of electricity in the helix which surrounds it; we have thus as it were electricity converted into magnetism and this magnetism again into electricity.



APPARATUS USED BY HENRY FOR INVESTIGATING EFFECT OF ROTATION OF IRON CORE WHILE SUBJECTED TO INDUCTION.

Another fact was observed which is somewhat interesting inasmuch as it serves in some respects to generalize the phenomena. After the battery had been withdrawn from the acid, and the needle of the galvanometer suffered to come to a state of rest after the resulting deflection, it was again deflected in the same direction by partially detaching the armature from the poles of the magnet to which it continued to adhere from the action of the residual magnetism, and in this way, a series of deflections, all in the same direction, was produced by merely slipping off the armature by degrees until the contact was entirely broken. The following extract from the register of the experiments exhibits the relative deflections observed in one experiment of this kind:

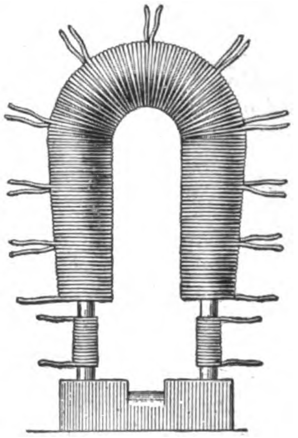
At the instant of immersion of the battery, deflection	40° west.
At the instant of emersion " " "	18° east.
Armature partially detached " " "	7° "
Armature entirely detached " " "	12° "

The effect was reversed in another experiment, in which the needle was turned to the west in a series of deflections by dipping the battery but a small distance into the acid at first and afterwards immersing it by degrees.

From the foregoing facts, it appears that a current of electricity is produced for an instant, in a helix of copper wire surrounding a piece of soft iron, whenever magnetism is induced in the iron; and a current in the opposite direction when the magnetism ceases; also that an instantaneous current in one or the other direction accompanies every change in the magnetic intensity of the iron.

The paper now proceeds to give the series of experiments, made in the last weeks of June, 1832, *after* seeing the brief notice of April of Faraday's results.

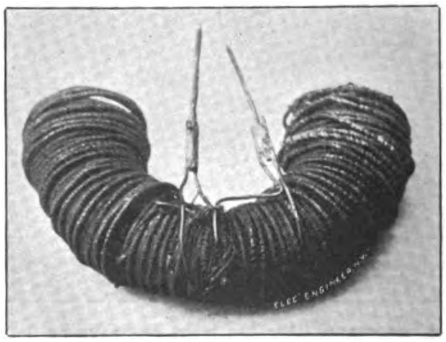
Since reading the account before given of Mr. Faraday's method of producing electrical currents, I have attempted to combine the effects of motion and induction; for this purpose a rod of soft iron ten inches long and one inch and a quarter in diameter, was attached to a common turning lathe, and surrounded with four helices of copper wire in such a manner that it could be suddenly and powerfully magnetized while in rapid motion by transmitting galvanic currents through three of the helices; the fourth being connected with the distant galvanometer was intended to transmit the current of induced electricity; all the helices were stationary while the iron rod revolved on its axis within them. From a number of trials in succession, first with the rod in one direction then in the opposite, and next in a state of rest, it was concluded that no perceptible effect was produced on the intensity of the *magneto-electric* current by a rotary motion of the iron combined with its sudden magnetization.



HENRY'S APPARATUS FOR INCREASING MAGNETO-ELECTRIC EFFECT.

The same apparatus, however, furnished the means of measuring separately the relative power of motion and induction in producing electrical currents. The iron rod was first magnetized by currents through the helices attached to the battery, and while in this state one of its ends was quickly introduced into the helix connected with the galvanometer; the deflection of the needle in this case was seven degrees. The end of the rod was next introduced into the same helix while in its natural state and then suddenly magnetized; the deflection in this instance amounted to thirty degrees, showing a great superiority in the method of induction.

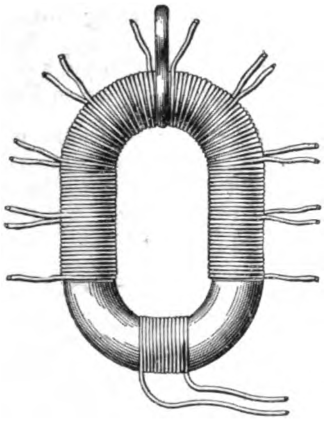
The next attempt was to increase the *magneto-electric* effect while the magnetic power remained the same, and in this I was more successful. Two iron rods six inches long and one inch in diameter, were each surrounded by two helices and then placed perpendicularly on the face of the armature, and between it and the poles of the magnet, so that each rod formed as it were a prolongation of the poles, and to these the armature adhered when the magnet was excited. With this arrangement, a current from one helix produced a deflection of thirty-seven degrees; from two helices both on the same rod fifty-two degrees, and from three, fifty-nine degrees; but when four helices were used the deflection was only fifty-five degrees, and when to these were added the helix of smaller wire around the armature, the deflection was no more than thirty degrees. This result may, perhaps, have been somewhat affected by the want of proper insulation in the



ARMATURE USED BY HENRY TO PRODUCE THE ELECTRIC SPARK. NOW IN THE CABINET OF THE COLLEGE OF NEW JERSEY.

several spires of the helices, it however establishes the fact that an increase in the electric current is produced by using at least two or three helices instead of one. The same principle was applied to another arrangement which seems to afford the maximum of electric development from a given magnetic power; in place of the two pieces of iron and the armature used in the last experiments, the poles of the magnet were connected by a single rod of iron, bent into the form of a horseshoe, and its extremities filed perfectly flat so as to come in perfect contact with the faces of the poles; around the middle of the arch of this horseshoe, two strands of copper wire were tightly coiled one over the other. A current from one of these helices deflected the needle one hundred degrees, and when both were used the needle was deflected with such force as to make a complete circuit.

When two clouds approach each other in the summer sky, the electricity in them is manifested by the lightning which leaps from one to the other. Henry desired a similar manifestation of the electricity he could make his magnets produce, and in the next experiment he obtains this in *the electric spark*.



Apparatus Employed by Henry for Producing the Magneto-Electric Spark.

But the most surprising effect was produced when, instead of passing the currents through the long wires to the galvanometer, the opposite ends of the helices were held nearly in contact with each other and the magnet suddenly excited; [see illustration] in this case a small but vivid spark was seen to pass between the ends of the wires, and this effect was repeated as often as the state of intensity of the magnet was changed.

In these experiments the connection of the battery with the wires from the magnet was not formed by soldering, but by two cups of mercury which permitted the galvanic action on the magnet to be instantaneously suspended and the polarity to be changed and rechanged without removing the battery from the acid; a succession of vivid sparks was obtained by rapidly interrupting and forming the communication by means of one of these cups; but the greatest effect was produced when the magnetism was entirely destroyed and instantaneously reproduced by a change of polarity.

It appears from the May number of the *Annals of Philosophy* that I have been anticipated in this experiment of drawing sparks from the magnet by Mr. James D. Forbes of Edinburgh, who obtained a spark on the 30th of March; *my experiments being made during the last two weeks in June*. A simple notification of his result is given, without any account of the experiment, which is reserved for a communication to the Royal Society of Edinburgh. My result is therefore independent of his, and was undoubtedly obtained by a different process.

The paper closes with the discovery of the "extra current", which we have shown Henry making in 1829, distinctly inserted here, we ask the reader to notice, as a phenomenon of the same order. Five years later, in 1834, this fact, rediscovered by Faraday, formed another star in his crown.

ELECTRICAL SELF-INDUCTION IN A LONG HELICAL WIRE.

I have made several other experiments in relation to the same subject, but which more important duties will not permit me to verify in time for this paper. I may, however, mention one fact which I have not seen noticed in any work, and which appears to me to belong to the same class of phenomena as those before described; it is this: When a small battery is moderately excited by diluted acid, and its poles, which should be terminated by cups of mercury, are connected by a copper wire not more than a foot in length, no spark is perceived when the connection is either formed or broken; but if a wire thirty or forty feet long be used instead of the short wire, though no spark will be perceptible when the connection is made, yet when it is broken by drawing one end of the wire from its cup of mercury, a vivid spark is produced. If the action of the battery be very intense, a spark will be given by the short wire; in this case it is only necessary to wait a few moments until the action partially subsides, and until no more sparks are given from the short wire; if the long wire be now substituted a spark will again be obtained. The effect appears somewhat increased by coiling the wire into a helix; it seems also to depend in some measure on the length and thickness of the wire. I can account for these phenomena only by supposing the long wire to become charged with electricity, which by its reaction on itself, projects a spark when the connection is broken.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—III.

BY

Francis B. Crocker and S. S. Wheeler.

Electrical Connections.—As already stated these should be very carefully cleaned and this may well be carried to the extent of rubbing them vigorously with clean cloth or chamois skin. Any of the metal surfaces used in making electrical contacts which are tarnished should be brightened with fine sandpaper or by scraping them, but all sand, metallic particles, etc., must be carefully removed afterwards. Particles of sand or dirt are often left accidentally between surfaces which should be in perfect contact.

Wiring.—It is very desirable to have a thoroughly competent lineman or electrician to connect a dynamo or motor to the circuit, see that everything is properly arranged and start the machine the first time.

The connections should all be made in a substantial and permanent manner. Good quality of insulated wire should be used and should be properly arranged and laid.

Temporary, loose or poorly insulated wires or connections are very objectionable. All circuits exposed to moisture should be supported on glass, porcelain or other waterproof insulators. Circuits of over 250 volts even where not exposed to moisture should also preferably be carried on porcelain or similar insulators, as shown in Fig. 4, and out of reach if possible, and the best insulated wire should be used.

Low-voltage circuits of 230 volts or under may be run in wooden moulding or cleats where entirely unexposed to moisture. Where wires pass through walls, floors, over pipes or are otherwise liable to injury they should be protected by hard-rubber tubing or other equally good covering. No wire smaller than No. 8 B. & S. gauge should be used for the arc current of 10 amperes, and other wires should be in proportion; that is, they should have from 800 to 1,200 circular mils per ampere. The former figure (800) is for small wires, in cool places; the latter figure (1,200) is for wires carrying heavy currents or high voltage and wires in hot places such as ceilings of kitchens, etc. No wire smaller than No. 16 should ever be laid to carry any current from a dynamo (smaller wires may be used for primary battery currents) no matter how small the current may be.

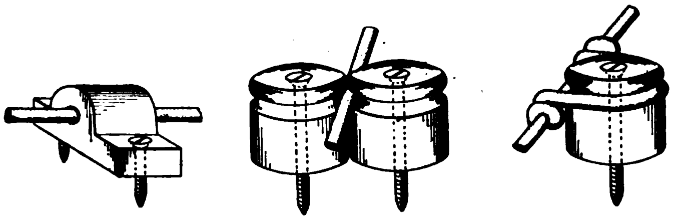


Fig. 4.—Wires Carried on Porcelain.

The above sizes of wire are rather larger than are generally given but it is wise to have an ample margin. Failure to allow a proper margin or factor of safety has been the cause of most of the troubles in all branches of electrical work.

In addition to the above allowances for current capacity or the ability of wires to carry the current without overheating, it is also necessary to consider the fall of potential or "drop" on wires. This loss ought not to exceed 5 per cent. in isolated plants, 10 per cent. in central station systems, and about 20 per cent. in long-distance transmission. That is to say, the voltage at the most remote point on the system should not fall below the voltage at the dynamo by more than these percentages. A "wiring table" is given at the end of this work for determining the size of wire required in various cases. A simple rule derived from Ohm's law applicable to all cases is, that the lost voltage obtained by multiplying the current in amperes at full load by the total resistance of the circuit in ohms must not be more than the given percentage of the voltage at the generator.

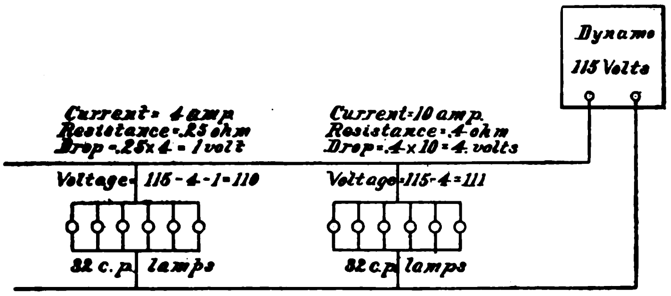


FIG. 5.—"DROP" ON BRANCHING CIRCUITS.

In the case of a branching circuit, shown in Fig. 5, or other case where the current is not the same throughout, the separate parts should be treated separately as indicated in the diagram. This calculation applies particularly to motors which are often put at the end of a long circuit or branch.

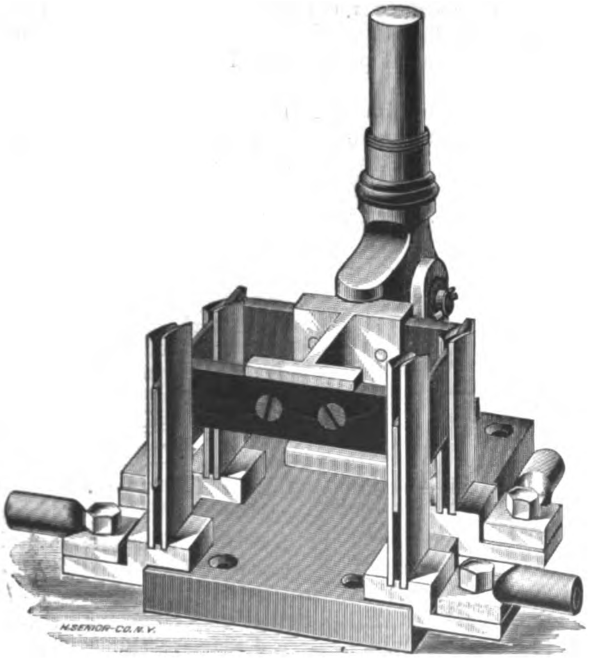

H.SENIOR-CO.N.Y.

FIG. 6.—DOUBLE-POLE QUICK-BREAK SWITCH.

Switches and Cut-Outs.—The bases of all switches, cut-outs, etc., should be of slate, porcelain or other fire-proof, non-porous, insulating material. On all constant-potential or multiple arc circuits, double-pole fusible cut-outs should be put where each branch starts. On all constant-current or arc circuits, double-pole cut-out switches should be put where the circuit enters any building and also near any motor or group of lamps on such circuits. All high-voltage circuits and any low-voltage circuit carrying more than three amperes should be controlled by double-pole switches or cut-outs which entirely disconnect both sides of the circuit, and they should also preferably have a "quick break," especially with direct currents.

The exceptions to this rule are first,—constant-potential dynamos which usually have single-pole knife switches, the other pole being permanently connected to the circuit; and second, constant-potential motors which generally have single-pole switches on the starting boxes, the other pole being always connected to the circuit. In the latter case, however, it is recommended to also put a double-pole quick-break switch in the circuit, as shown in Fig. 6.

Diagrams of Connections are given in each important case to show the actual connections which are necessary. But when a machine is to be "connected up" a competent electrical engineer should be consulted or an exact diagram should be obtained from the maker of the machine, as its connections may be peculiar and cause serious trouble. Diagrams merely represent the path of the wires in the simplest way, the important thing in electrical connections being *which* parts or wires are connected, not *how* they are connected. Whether the path be straight or crooked, vertical or horizontal, etc., is of no consequence. Diagrams of the three most important cases of dynamo connections are here given. The other diagrams of dynamos and motor connections are given hereafter.

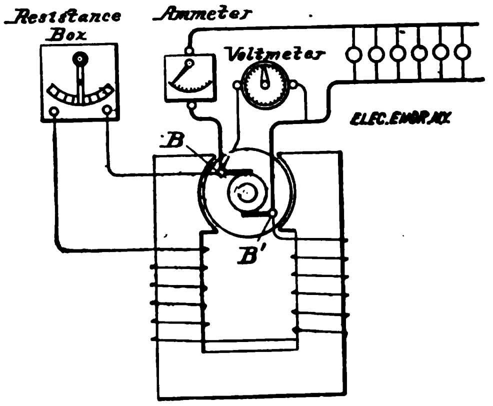


FIG. 7.—SHUNT DYNAMO ON CONSTANT POTENTIAL CIRCUIT WITH LAMPS IN PARALLEL.

Shunt Dynamo on Constant-Potential Circuit is represented in Fig. 7 with the necessary connections. The brushes B and B, are connected to the two conductors forming the main circuit, also to the field-magnet coils *through* a resistance box to regulate the strength of current and therefore the magnetism in the field. A voltmeter is also connected to the two brushes or main conductors to measure the voltage or electrical pressure between them. One of the main conductors is connected to an ampere meter which measures the total current on the main circuit. The lamps are connected in parallel between the main conductors or branches from them.

FRANKFORT EXHIBITION SURPLUS.

THE surplus, after paying all expenses, amounts to $38,000. Out of this sum the town of Frankfort and the local Chamber of Commerce will receive back their guarantees, whilst to the exhibitors will be returned a large amount of the costs for space and power.

THE COMPOUND ENGINES OF THE BUFFALO RAILWAY CO., OF BUFFALO, N. Y.

BY

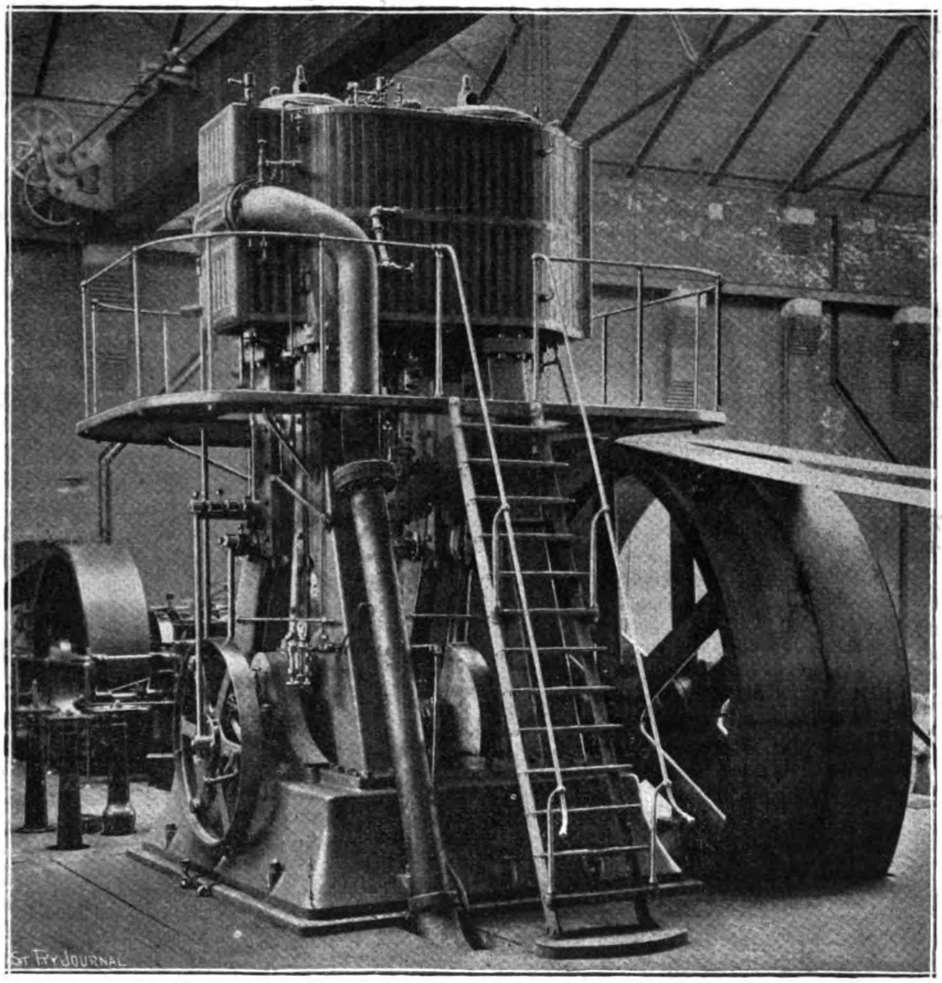
C. J. Field.

THERE has been recently installed in the power house of the Buffalo Railway Co. the first of two engines which have been specially designed for electric railway work. The result is that the engine differs in detail from most engines used on this class of work. The general type is that of a vertical 2-crank compound condensing, with cranks at 90° to facilitate starting and stopping. The engine was designed to run condensing or non-condensing, and is running in the latter manner to-day on account of the condenser house being as yet unfinished, and is giving perfect satisfaction.

The engine, which is illustrated in the engraving, Fig. 1, drives two No. 60 Edison railway generators by means of two 24 inch belts from the fly-wheel of the engine, which is 12 feet in diameter and weighs 36,000 pounds. The total weight of engine is about 90,000 pounds. This engine has a rotative speed between that of a Corliss and high-speed engine, running 138 revs. per min., but with a piston speed of 600 feet per min. The high-pressure cylinder is 17 inches in diameter; the low 33½ inches, and the common stroke is 38 inches; on 125 lbs. initial pressure the engine develops 450 horse power.

The steam distribution is effected by means of four light, flat, double-ported and perfectly balanced valves to each cylinder, the exhaust valves being controlled independently from the steam valves, and giving different degrees of cut-off and compression. The clearance is cut down to as low as consistent with necessary compression, being 8 per cent. in the high and 4 per cent. in the low pressure cylinder.

The high-press cylinder is fitted with a "liner" and steam-jacketed, and the receiver is located between the cylinders. The steam valves on the low-pressure cylinder have a peculiar, quick motion, caused by a neccentric operating through the intervention of a set of rocker arms, thus giving a sharp cut-off on the low pressure cylinder.



COMPOUND ENGINE OF THE BUFFALO RAILWAY CO.

The speed of revolution of the engine is regulated by means of a shaft governor. All are aware of the necessity for good regulation in any engine under sudden changes of load, and especially in electric railway work. The steam valves on the high pressure cylinder are controlled directly by this shaft governor.

There has been a question raised as to the possibility of governing the speed of such a large unit as this engine represents by means of a centrifugal shaft governor so arranged that it could move the valves direct and yet be sensitive to changes of load. That it is possible is shown by the fact that this engine is operated in this very manner and varies only by $\frac{1}{2}$ revolution in a change of load from 360 to 700 amperes. The governor itself is very sensitive having only one weight, two arms and four pivoted joints.

The details of the engine have been very carefully worked out. The cross-head slippers are babbitted and set out by means of liners instead of wedges. The cross-head is forged solid on the end of the piston-rod. The crank end of the connecting rod is of the standard marine type and the cross-head ends are forked. All bearings are babbited, and in the case of the main bearings have cast iron babbitt-lined shells, around which water is circulated to prevent serious trouble in case of overheating. The back of the slides is also water-jacketed.

The lubrication of the different parts is effected by means of grease instead of oil; it is distributed in pipes by pressure from a central reservoir, very much like an accumulator in a hydraulic plant, the grease being forced to every part on the engine and controlled in amount by stop cocks at each bearing. The second engine of this type is now being erected at the station.

These particular engines were built for the Buffalo plant by the Lake Erie Engine Works, of Buffalo, and they are building a standard electric railway and lighting engine in compound and triple expansions embodying the features of the Buffalo engine and which are used for direct connection to multipolar generators, up to 5,000 horse power.

The Buffalo engine was installed through the Field Engineering Co., who designed and equipped the entire railway system in Buffalo for the Buffalo Railway Co., of which Col. Henry W. Watson is president, and Mr. H. H. Littell general manager.

THE THEORY OF THE PERRET MAGNETIC FIELD.

BY

Frank A. Perret

MR. H. R. WELLMAN'S criticism in THE ELECTRICAL ENGINEER of Jan. 20, refers, I suppose, to the description of my method of multipolar field magnet construction as stated in Sec. 2 of an article in your issue of Jan. 6. It is evident that he has misunderstood the purport of the claims for superiority as therein described. The writer of that article had no intention of going exhaustively into the subject and possibly clearness was sacrificed to brevity. Lest others should also be misled, allow me to state that it is not claimed for this design of magnetic circuit that it ensures lower speed than the ordinary multipolar type *independently of the quality and lamination of the iron.*

The advantages claimed for it are:

1, the use of separate magnets presenting both poles to the armature and isolated magnetically one from another except through the medium of the armature core, instead of double the number of magnets uniting in a common yoke.

2, the employment of only half the usual number of field magnetizing coils and

3, the lamination of the field magnets.

Besides the advantage of simplicity this construction is most effective in securing an equal magnetic distribution.

I find that the section referred to above is based on an article written by me in the year 1890, in which I attempted a simple explanation of how, in multipolar machines, a lower speed is obtained than in machines of the bipolar type. In practice, all the lines of force do not enter and leave the armature at the consecutive field poles, but the number of lines crossing the "entrefer" or air-gap to or from each pole is exactly the same as if they did so and the result, as Mr. Wellman shows, is precisely the same. It was not thought necessary at the time to point this out, as the diagram clearly and correctly indicated the path of the magnetic flux in the machines of my design.

What we call lines of force are not *lines*, having individuality. The magnetic flux from one pole divides in the armature into two streams, one of which re-enters the same magnet at its opposite pole and the other reaches the adjacent pole of the neighboring magnet (having traversed a path of the same length and the same reluctance as the first) and loses its identity in the stream generated by that magnet. It will thus be seen that the diagram is a correct representation of the magnetic circuit in question and that in no other way can it be properly shown.

THE STANLEY AND KELLY ALTERNATING MOTOR.[1]

IT has appeared necessary to us that any system of power distribution by alternating currents of electricity to be commercial, should be operated on the existing systems of current supply, viz., the multiple transformer system of standard frequency. In order to produce a motor to fit these conditions we have studied an ordinary continuous current motor when supplied with alternating currents, for it is evident that if the electrical reactions produced by alternating currents in a motor are similar to those produced by continuous currents, the problem would be a comparatively simple one.

The motor described below is the invention of Mr. William Stanley, Jr., and Mr. John F. Kelly, and is the outgrowth of a motor in which a condenser is used in the field circuit. The present form makes use of the condenser and embodies several important improvements. In general the motor is of the two or four pole type (although the number of poles is not restricted) having a well laminated field and armature. The field coils are of comparatively few turns, which may be placed on the poles as in the ordinary type of direct current Motor, and are connected either in series or multiple, through a condenser to a source of alternating current, as shown in Fig. 1. The armature is of a specially wound closed circuit type, having an ordinary Gramme commutator on which bear two brushes placed on the neutral line or lines. These brushes are connected to the source of alternating current supply. The transformer furnishing current to the shunt type of motor has two secondaries, one of which supplies the field with a constant current, while the other supplies a variable current to the armature.

Before taking up the description of the motor in detail, let us see the effect of applying an alternating E. M. F. to a continuous current shunt wound motor. We will consider a motor wound with 3,000 turns on its field, which when in circuit furnishes the necessary magnetizing power of 500,000 C. G. S. lines of magnetism through the armature. Just as in a transformer the reactive effect of the magnetism on the primary coil develops a counter E. M. F. of self-induction, so also the effect of the field magnetism on the field coils develops a counter E. M. F. which practically annihilates the impressed E. M. F., and by preventing nearly all the current from flowing through the field circuit greatly reduces the magnetism.

It is of course possible to apply a sufficiently high E. M. F. to give the required field magnetization, but a brief calculation shows that under the conditions assumed, this E. M. F. would be about 9,000 volts, a pressure entirely out of the question. The magnetization set up through a given circuit is approximately proportional to the product of the number of turns and the current, viz., the ampere turns, which product may, of course, be obtained with a fewer number of turns and a larger current. This has an important bearing in reducing the applied E. M. F. on the field. Instead of 3,000 turns suppose we take 250; to give the same magnetization the current will have to be twelve times as great, and calculation shows the necessary E. M. F. to be about 750 volts. Fortunately it is not necessary to employ this as an impressed E. M. F. from the transformer, for by inserting into the field circuit a condenser of proper size (dependent on the number of alternations, the reluctance of the circuit, the turns, etc.) there is developed an E. M. F. between the condenser terminals that always opposes the E. M. F. of self-induction in time and value, and destroys all effects of self-induction, allowing the same amount of current to flow as if the circuit were supplied with a continuous current, neglecting of course losses due to extra apparent resistance by hysteresis and Foucault currents. By inserting a condenser in the field circuit any low E. M. F., as 100 volts, may be used to magnetize the field, thus obviating the use of high potentials. The employment of the condenser has also the advantage of reducing the lag of the current behind the applied E. M. F., a result which would take place if a field E. M. F. of 750 volts were used, and no condenser was in circuit. Thus two of the difficulties of operating a motor by alternating currents are overcome: First, that of obtaining the required magnetization to flux the field without employing a high E. M. F.; second, that of causing this magnetization to occur at the proper time, viz., in phase with the E. M. F. applied.

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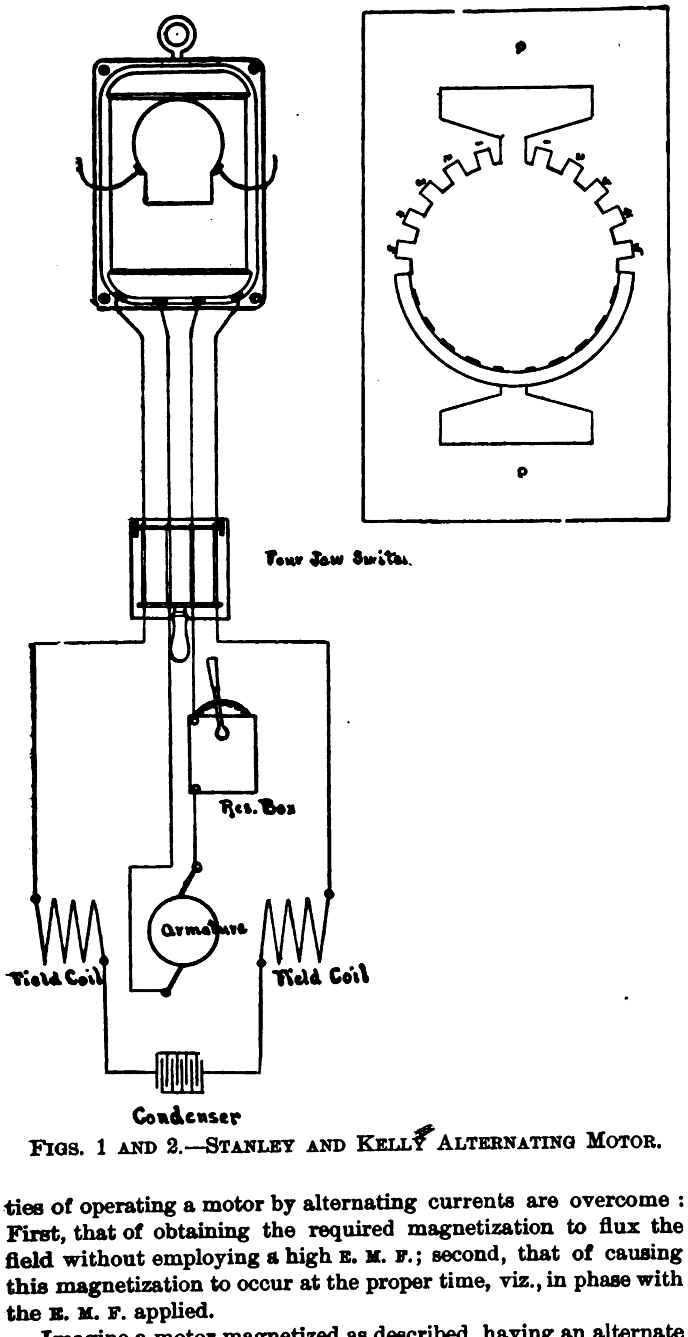
[1] Abstract of a paper read before the Chicago Electric Club by Wm. Stanley, Jr.



FIGS. 1 AND 2.—STANLEY AND KELLY ALTERNATING MOTOR.

Imagine a motor magnetized as described, having an alternate current applied to its armature; there will be a lag of the current in the armature behind its E. M. F. as was the case of the field current. To give the maximum amount of power and torque for given values of currents in the field and armature they must flow in unison; for if there be a lag between the field magnetization and armature current, during that part of an alternation in which the currents coincide, the pull will be in one direction, and during that part of the alternation in which the currents are opposed, the pull will be reversed. To overcome this difficulty we have wound about the armature parallel to the direction of the field magnetization a number of short circuited coils sunk in slots in the field poles, as shown in Fig. 2. This short circuited winding is only acted upon by the current in the armature coils, and as a short circuit in the secondary coil of a transformer destroys the self-induction of the primary circuit, so the currents induced by the armature current in the short circuited coils reduce the self-induction of the armature coils, and consequently the lag in the armature current, and bring it in phase with the applied E. M. F. Clearly the E. M. F.'s applied to the field and armature coincide (because they come from the same transformer), and as there is no lag in either the field or armature current, it is evident that the field magnetization and armature current must coincide, and that the torque of the motor must always be in one direction. Thus another difficulty is removed.

If a motor made as described be supplied with alternating currents it will start from rest with the same torque as if supplied with continuous currents. If it is run free of load the current in the armature will be small, and as load on it is increased the current in the armature will increase in like proportion. In short, it will behave exactly like a continuous current motor.

MASSAGE WITH CURRENTS OF HIGH FREQUENCY.[1]

BY H. NEWMAN LAWRENCE, M. I. E. E.

THE paper by Mr. Nikola Tesla, which you publish in your last issue, is very interesting, and, doubtless, as it comes from the other side of the water, will attract some attention in English medical circles.

The suggestion set forth is not, however, so entirely new as the author seems to suppose. Raising the temperature of the human body for curative purposes by "connecting it with a source of rapidly alternating high potential" has been practised by myself for some time past, and I believe by others also. I do not say that we have gone so far as to thoroughly warm a nude body with the surrounding air at freezing point, but we have frequently produced a pleasant glow over the whole body, and warmed chilled extremities.

As regards the therapeutic value of such treatment, my own experience, gained mainly at the late Institute of Medical Electricity, Limited, leads me to conclude that though this method is valuable to a certain extent, yet it is more useful as an adjunct to, than as a substitute for, other forms of treatment. In saying this, I must admit that the method under which I work falls far short of the conditions referred to by Mr. Tesla. I speak of results obtained from the use of an Apps coil, giving a difference of potential of about 10,000 volts, and whose alternations could hardly be called "rapid" in this connection. It is only fair to assume that the effects observed would be much increased by increased rapidity of alternation.

The title Mr. Tesla has chosen for his paper is somewhat misleading, and it is hard to see the connection between the word "massage" and the matter dealt with. I presume he means that the effect produced by electricity thus used is similar to that obtained by massage. If so, the comparison is a very superficial one, for the effects can only be in a small degree similar, though undoubtedly the raising of the surface temperature is an accompaniment of both. I might add that in many cases I find the best effects obtained from the use of massage in addition to or in combination with the high potential coil currents above referred to.

"FAR SUPERIOR."

THE general manager of a large central station in Pennsylvania writes us, in renewing his subscription: "I desire to express my appreciation of your magazine. I think it is far superior to any other electrical paper published in the country."

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[1] London *Electrical Review* of Jan. 15.

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VOL. XIII. NEW YORK, FEBRUARY 3, 1892. No. 196.

The discoveries of inductive science need no apparatus. They are made and matured in the brain; and to record them is the only physical incident to their existence or development.—Edward N. Dickerson.

ELECTRICITY IN THE HOUSEHOLD.

AN advance copy of a most interesting little pamphlet has just reached us, from the pen of Mr. H. Ward Leonard, on the subject of "Electricity in a Modern Residence." As a matter of fact the pamphlet is not quite so broad in treatment of the subject as might be gathered from the title, but seeing that it deals with questions of light, heat and power, it will be admitted to cover all the principal ground that at present falls within the province of electrical engineering.

The issuance of this brochure is so timely and suggestive as to invite more attention than is generally bestowed on literature of its class. It marks very definitely the beginning of a new period in electric lighting, that, namely, in which current is brought within command of the ordinary household, whether it inhabits a "modern residence" or is fortunate enough to occupy one of the old-time mansions that compensate in dignity and comfort for what they lack in stained glass and frenzied decoration. Mr. Leonard points out that the illuminating companies have been slow in reaching residential districts, and says truly that it is because paying loads have chiefly been found in business sections of the town or city. Taking a business area with a capacity of 10,000 lights and a dwelling area of 10,000 lights—in the former instance the steady load will run up to even more than 7,500 lights, while in the latter it often may not reach 1,000 lights. Now as expenses in each case are the same, which field of work should an illuminating company cater for when it starts? There can be but one answer to the inquiry. But when a station has worked up to a good degree of its possible load in a business region, it begins to be worth while to keep up the load line more hours and at a higher ampereage, utilizing the station capacity to the fullest; and here the residence field comes in. A great many stations are just at this point now, we think, and they could not do better than circulate Mr. Leonard's pamphlet among their possible customers, especially those who, after sitting under the cheerful incandescent lamp in their offices and factories, do not wish to go home and stifle in the vitiated atmosphere of gas.

Mr. Leonard puts the price of electricity and gas on a par. That is about right, but, of course, depends on local conditions. Even if electricity cost a little more, as it may in some places, people are ready and willing to pay the slight difference. They get it back in better health, purer air, and a longer freshness of paint, furniture, pictures and books. The price of wiring, Mr. Leonard estimates to range from $1.50 to $4 per lamp, or $2.50 per lamp on the average. The question comes in, who is to pay for the wiring? We say, not the company. If the business is so profitable that they can afford to do it, let them lower the price of current instead. For the operation of various power devices, Mr. Leonard allows $50 a year, even when used a good deal. That ought to be enough. The price of a ventilating fan complete he puts at $25; an ice cream freezer, and motor, $100 to $200; an automatic electric pump, $200; a dumb-waiter complete with motor of ¼ h. p. about $150. But it strikes us that some of these might be run by the same motor. To these he adds an electric elevator costing $2,000 to $3,000 and taking about five dollars' worth of current a month. Stairs are a barbarism, but an elevator must evidently remain a luxury except in houses of some pretensions. But even then, there are at least a thousand residences in New York City alone, where electric elevators could well be afforded by their wealthy occupants. We note that Mr. Leonard proposes to run the bells from the lighting circuits. For country houses, especially along the coast, he proposes an equipment combining a windmill and storage batteries, the whole costing about $1,500. We know of no clinching argument against such an outfit.

As might be expected, Mr. Leonard touches also on electric heating, and electric appliances for cooking, ironing, etc. We see now and again some very flat-footed proofs that electric heating is enormously costly, but the estimates never make any allowance for the space required by a coal cellar and furnace that will occupy at least one-tenth of a house renting at $3,000 or $4,000 a year; nor do they touch on the cost of bringing in coal and removing ashes; nor on the wear and tear of furnaces, ranges and stoves; nor on the little extra payment of $3.50 a month to a man from outside to look after the furnace. The same estimates leave out of sight the fact that two or three rooms in the house are up to boiling point, without relief, while in other rooms iced water can always be made on the spot. These estimates again, if they deal with steam heating, forget the terrific bombardments between the United States and Chili that go on inside the heaters, and are always worst in the midnight hours when one is desperately sleepy.

Electric heating is the beau ideal of warmth as electric lighting is of illumination. And as we have already "arrived" with light and power, the day is certainly not far distant when the electrical engineer will "get there," too, with electric heat, as one of the boons that his art and skill provides for a welcoming public.

THE LAUFFEN-FRANKFORT TRANSMISSION.

The electrical event par excellence of the year 1891, was undoubtedly the successful accomplishment of the transmission of power by alternating currents of high potential between Lauffen and Frankfort, a distance of some 112 miles. The special committee appointed to test this installation have not yet made their official report, but the interest with which the large body of electrical engineers has followed these experiments is such as to warrant us in bringing forward a preliminary statement of the results obtained at Frankfort, as they appear in an article in the *Schweizerische Bauzeitung* by Mr. Emil Huber, director of the celebrated Oerlikon Works. According to Mr. Huber, the average potential used in the experiment was 16,000 volts, and only towards the end of the experiment was it increased to 30,000. The fears at first expressed that the oil insulators would not stand this pressure proved groundless, for as an actual fact only a single insulator broke down, and that under a strain of 30,000 volts.

Two other disturbances were caused by the breaking of a wire and by a defective insulator, due to a fault in the manufacture, respectively. It is interesting to note that the cost of the installation per effective horse-power—on the assumption that 300 h. p. was delivered to the line at Lauffen, and that the whole amount of this energy was available in Frankfort—was $300, of which the line itself involved a cost of $210!

But the next most interesting question from the electrical engineer's standpoint is that of the efficiency of transmission obtained in the Lauffen-Frankfort installation.

During the experiments, regular readings were taken at both ends of the line, and voltmeter readings were taken between one conductor and the neutral point in each of the three circuits, which averaged 54 volts, the currents reading 500, 490 and 500 amperes respectively in the primary circuits. Leaving out of consideration the lag between the current strengths and the potentials, the mean electric power delivered to the line was 80,500 watts. At the same time, the Frankfort end of the line delivered current for 1060 incandescent lamps of 16 c. p., which absorbed 58,000 watts. According to this estimate, therefore, the installation showed an efficiency of 72 per cent. Mr. Huber, however, points out that in reality the efficiency was actually higher, due to this lag, and he estimates it to be about 5 per cent.

Regarding the doubts which were at one time expressed as to the influence of rain and foggy weather, it was shown that these phenomena had no material influence on the working of the line, no direct leakage to earth having been observed, the instruments showing the same indications both in wet and dry weather; so that, if there actually was such a loss, it was negligible. The losses due to condenser action of the insulators were also found to be but very small. In general it is claimed that no abnormal phenomena were developed in this transmission which could not be calculated and allowed for in advance for any similar installation to be made in the future, and that the losses are similar to those occurring in low-tension systems and which can be determined by Ohm's law.

In the absence of the official report of this installation, the results, as stated above, coming as they do from an interested party, must still be considered of a tentative nature, but if they should be substantiated by the official report of the commission, the Lauffen-Frankfort transmission may well claim a high place among modern feats of engineering.

ELECTRIC POWER IN MILLS AND FACTORIES.

Closely succeeding the development of the electric railway field, has come the exploitation of electric mining, which is now going on apace. A new department of work, has opened up, however, that in some respects, combines the features of the other two departments of work, and bids fair to equal either in importance and magnitude. We refer to the use of electric power in mills and factories, with the object of driving elevators, locomotives, fans, shafting, tools, machinery, all from a central station that may also furnish light. Plants of this kind are springing up right and left, and the article that we publish in this issue on the successful utilization of electric power on these lines at the big Edison Schenectady Works emphasizes the extent to which the new departure has already been carried as a mechanical and economic revolution. Here, for example, in works covering not less than 12 acres and employing from 3500 to 4000 men, we find nearly 50 electric motors of a capacity of about 1500 h. p. delivering power on the call and with instant regulation at the generating point. And so it goes—in tile works at Zanesville, O.; in roller mills at St. Paul; in the Fraser & Chalmers shops in Chicago; on the World's Fair grounds; in candy factories at New Haven, breweries at Milwaukee, and all along the line of American industry.

PORCELAIN vs. GLASS INSULATORS.

The appeal to the porcelain manufacturers of America, issued through our columns by Mr. Francis W. Jones, has served to bring out several interesting communications on this subject, two of which appear in this issue. Mr. Stott gives the results of tests on what is known as the Johnson fluid insulator. The excellent quality of this type of porcelain insulator was already established, but if anything were wanting to confirm it still more it could be found in the results of the Lauffen-Frankfort transmission in which this type of insulator was used exclusively. As a matter of fact, only one single insulator "broke down" electrically. Indeed, it may be safe to say that for high tension transmission, where it is desirable to avoid appreciable leakage, the fluid insulator will be used exclusively.

On the other hand, Mr. C. Colné, a well-known glass and porcelain expert, who has been a U. S. commissioner to foreign expositions, on this subject, makes a plea for glass, and raises a number of very important points on the glassmaker's side.

PORCELAIN INSULATORS FOR OVERHEAD LINES.

BY

C. Colné.

JUDGING from your editorial of the 20th instant on "Porcelain Insulators for Overhead Lines" you seem to think the subject of much importance. It may, perhaps, interest your readers to discuss it a little further.

The requisites of a good porcelain insulator Mr. F. W. Jones says are, that it should be made "of simple earths only, both in body and glaze, and of the same material without any metallic oxides, the body and glaze to be vitrified together at a high heat. It must be resistant to all influences of heat, cold, dampness, acid or alkaline fluid or gases."

Not having read the authorities quoted by Mr. Jones—the works of Messrs. Pope and Preece and Sivewright—I am unable to judge whether the requisites for a good porcelain insulator agree with his views.

In comparing glass insulators with those made of porcelain we should first compare the component parts of each material. Glass used for insulators, the common green glass, is usually made up of silica (sand), lime and soda (carbonate or sulphate). The sand used usually contains oxide of iron, which colors the glass green. The lime used is more or less pure and often contains also oxide of iron. The practice here is to use carbonate of soda, while in Europe it is almost invariably the sulphate.

Silica, the principal component part of glass, represents from 30 to 80 per cent. of its weight, according to the nature of the glass. It is quite insoluble in water, and resists all acids except hydrofluoric acid. If glass contains a large proportion of alkali it is very apt to absorb moisture and thereby injure its insulating qualities. Should the sand used contain also a large proportion of iron its insulating virtues are also impaired. The same may be said of lime. Taking for granted that a dense or hard glass should be the best for insulators, glass manufacturers should always make insulators of glass rich in silica, with but little alkali and fuse it at a high temperature. Unfortunately the temptation for having glass which "works easy" is too great, and alkalies are often put in the batch in excess to save time and labor, and save the care of maintaining the furnaces at a high temperature.

If Mr. Jones is correct in his statement regarding the quality of a good porcelain insulator, that it should have a good smooth surface, be perfectly vitrified throughout so as to be homogeneous, impervious to moisture and free from flaws, I am sure good hard glass well vitrified and as free as possible from oxide of iron and alkalies should meet the purpose as well as porcelain.

Mr. C. H. L. Smith's commercial appeal to those using porcelain insulators to pay the proper price for a good article may be of value to him, but in my opinion there should be but little difference in the price of glass and porcelain insulators, the difference, however, to be in favor of the latter.

Good hard porcelain ("porcelaine dure" of the French), such as Mr. Smith says he is making, is usually composed of kaolin, plastic clay, feldspar, sand and chalk. These materials exist in abundance in the United States, as I had occasion to find when I wrote the report of the United States Commission on glass at the Paris Exposition of 1878. It is true, however, that their preparation costs more than the materials used in glass. The same impurities are found in them as those existing in glass materials. Hard porcelain materials being less fusible than those used for glass, a higher degree of heat is necessary to vitrify them. Vitrification, however, never attains the same degree as in glass. Hence, if thorough vitrification is required, as stated by Mr. Jones, glass should be superior to porcelain. Porcelain may be looked upon somewhat as a semi-fused opaque glass. The resistance to acids, moisture, heat, cold and alkalies in porcelain is about the same as in glass.

I do not quite understand Mr. Smith's statement that glaze is unnecessary in porcelain insulators, and that the only use of glaze is to keep them from soiling. Since he says that he has "thoroughly and carefully investigated the whole matter," I am a little diffident in disagreeing with him. It must be apparent, however, that if porcelain unglazed becomes more quickly and readily soiled, it is owing to its porousness, which is the result of a partial vitrification only. The glaze is a thorough glass enamel which covers the pores and prevents moisture from penetrating—a better vitrification than the porcelain itself. This, it seems to me, is quite necessary for good insulation. Neither do I agree with him that porcelain insulators are not used because of "first cost." I believe that our pottery manufacturers, if they are assured of a market, will find a way to make porcelain insulators of good quality at a slight advance upon the price of glass. As for the tariff question preventing the purchase abroad, I am glad it does, because we have everything here to make good porcelain insulators, and we should make them and keep our money at home. This may not be good Free Trade doctrine but it appeals to the national pocket, which oftentimes is a more sensitive article than the national heart. I should be pleased to see this discussion of insulators continued in your paper. I should especially be pleased to have an explanation from some electrician showing why porcelain is a better insulator than glass, and a positive definition of the requisites for a good insulator. I do not think that Messrs. Jones and Smith have been sufficiently explicit upon this point, as I have shown in a rough manner that glass possesses the qualities said to be needed, as well as, and somewhat better than, porcelain. Faites jaillir la lumière electrique on this subject.

ACCUMULATOR CARS PROPOSED FOR GLASGOW.

IN view of the termination of the Glasgow Tramway Company's lease with the Town Council, says the *Electrician*, and the probable resolution of the corporation to work the local tramway system as a municipal concern, the tramways committee have lately given their special consideration to the mode of traction which they should recommend the town council to authorize. So far as they have been able to formulate their views on the subject, they have come to a resolution in favor of electric traction; and if they get the sanction of the corporation to proceed further, it is highly probable that they will make a beginning with at least 50—possibly 100—accumulator cars, which it is proposed to place on one or more of the east and west tramway lines, all of which are practically level. The General Electric Power and Traction Company have offered to the Glasgow Corporation Committee on Tramways to work the cars for 5d. per car mile, a fact which has given great encouragement to the Committee.

"L'INDUSTRIE ELECTRIQUE."

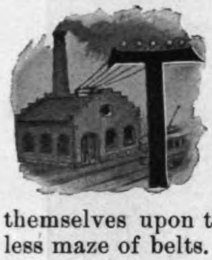
THIS is the title of the new French electrical journal, the first number of which has just reached us. With M. E. Hospitalier as editor-in-chief and M. G. Roux as secretaire de la redaction, it is hardly necessary to remark that the new journal will be found to be well abreast of the times and accurate in all its details. The size and general get-up of the new journal is almost identical with that of THE ELECTRICAL ENGINEER, thus making it extremely handy for reference and filing. We note among the founders of the journal some of the best-known electricians and electrical firms in France. *L'Industrie Electrique* is published by M. A. Lahure, No. 9 Rue de Fleurus, Paris, France, and will appear on the 10th and 25th of each month. The subscription price is $5 per annum.

THE UTILIZATION OF ELECTRIC POWER AT THE SCHENECTADY EDISON WORKS.

BY

T. C. Martin

I.



TWO features have been conspicuous in the construction and operation of nearly all American mills and factories up to the present time. If steam is the motive power, long and heavy lines of shafting obtrude themselves upon the eye, combined with an endless maze of belts. If water is the prime energy, not only is the mill begirdled with whirring belts and gridironed with heavy shafts, but it is huddled down close to the stream, sacrificing light and air for the sake of cheap power.

Hitherto it has been taken for granted that these conditions are permanent and must be dealt with in all power transmission within buildings. The assumption is, however, so far from the truth that any new mill equipping for power transmission by other than electrical methods may safely be said to illustrate the ideas of the past rather than the practice of the future; and the work of transition has already been begun with such vigor that even now the adoption of electric motors for mills and factories promises to be as rapid as the introduction of the electric light. But ten years ago the use of electricity as an illuminant in a mill was discussed as a suspicious innovation. To-day it is without a rival in popularity. A similar course of events may be looked for with regard to the use of electricity for power transmission, except that the stages of advance will be the more rapid because in a great many instances the existing circuits for lighting are of capacity enough to carry ample current for motors also.

But it may reasonably be asked—What are the peculiar advantages that electric power has as compared with methods so long approved? The answer is, that electricity is at once safer, more convenient, more flexible and more economical. All the various services of driving machinery, operating elevators, propelling freight cars, running pumps and furnishing ventilation may be performed from the one set of wires; whereas, with any other power, isolated engines, all under separate government are necessary. It goes without saying that the wires are far less bulky or burdensome than long lines of shafting and extended systems of steam pipes. In many mills, the shafting, badly put up, alone consumes 30 or 40 per cent. of the whole power available, while it must be a poor electric power plant that cannot show 75 per cent. efficiency in the transmission. Even if it be desired still to run lines of shafting, a motor can be attached to each line and thus the benefit be secured of having smaller units each free to continue, no matter what may happen on any other section or floor. Not a few manufacturers want power right at the machine to be operated, while others desire the power to be movable at will from tool to tool. This electricity answers for most admirably, with the added recommendation that in its use each lessening of the load on the generating plant is responded to immediately in a smaller consumption of current and fuel. Another noteworthy economic feature is, that in order to bear big shafts, mills often need stronger and more expensive walls, or are supplemented by belt towers or have belt holes pierced from floor to floor, allowing fire to travel freely and quickly.

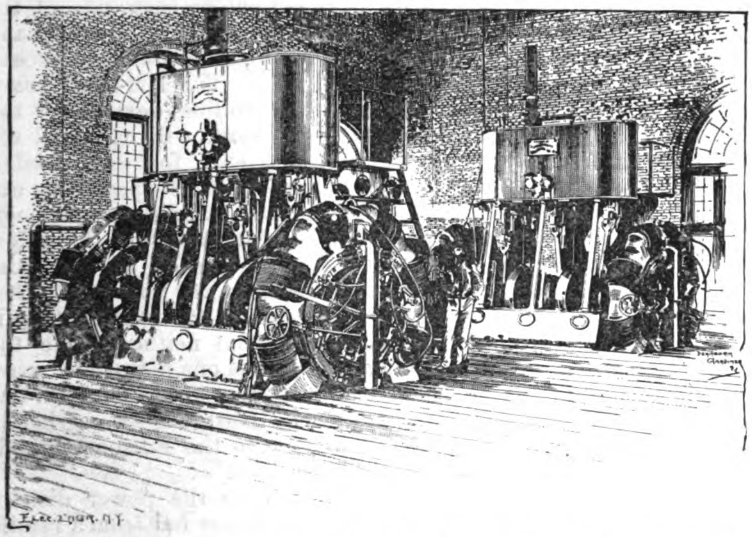


FIG. 1.—PORTION OF THE POWER HOUSE, EDISON WORKS, SCHENECTADY.

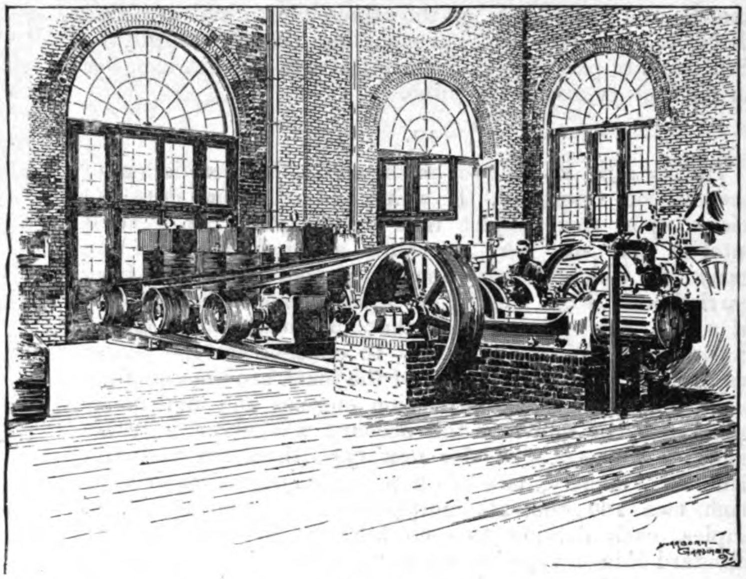


FIG. 2.—PORTION OF POWER HOUSE, EDISON WORKS, SCHENECTADY.

II.

A great many more points of superior merit in electric power transmission might be cited, but in this instance as in every other of the kind, the proof of the pudding is in the eating. As a matter of fact several mills and factories are now running in which the arguments outlined above are fully borne out, but the public still has little conception of the extent to which the principle has been accepted and carried. This general ignorance is excusable, considering that very few electrical people are aware of the fact that at the huge works of the Edison General Electric Company at Schenectady, N. Y., employing about 4,000 men, over 1,900 h. p. is to be transmitted by wire from a central station. The plant in question is already so large and does such a variety of work that a little study of its peculiarities will repay any one. It is beyond doubt the largest example to-day in the world of the advantages of electric power transmission, but so striking have been the gains from it that it is evidently destined to help mark the beginning of the new era in large mills and factories. The work done at Schenectady is, perhaps, the more interesting from the fact that with the current from these circuits all the various power apparatus in actual use or under test for mill work, mining, ventilating, etc., is run. There is thus obtained a wonderful range of experience that is not to be secured anywhere else; and certainly one of the most remarkable spectacles that ever greeted the eye of the engineer is this vast aggregation of mechanisms at their regular daily task or under trial, all in one factory, all driven by the same unseen energy, and all responsive to the slightest movement of a switch. The central plant furnishes current to scores of little $\frac{1}{10}$ or $\frac{1}{16}$ h. p. motors on one floor, while on an adjoining floor it is driving motors of 15 or 25 h. p. on the same circuits, and attached direct to a ponderous tool or machine. In other words, the Schenectady plant shows at once the uses of electric power in the factory and in the mine.

III.

During a recent visit to Schenectady, by permission of the Edison Company, the writer obtained some data and views upon this subject that should prove of general interest and are here presented as an evidence of the extent to which the principles suggested above have been carried out. Figs. 1 and 2 are illustrations of the interior of a fine new power house that has been built at the Schenectady Works expressly to concentrate the power supply. A leading feature of the plant are the combinations of Edison triple expansion engines and multipolar generators, of which a full account was given in these columns last year. Of this new type there are virtually four sets, namely, two 300 h. p. triple automatics driving each two 100 kilowatt multipolars, and two 150 h. p. triples, each driving two 60 kilowatt generators of the standard Edison type known as "the 1885." In addition to these are found one Armington & Sims engine 10 x 12 of 150 h. p. driving one 100 kilowatt railroad generator and two 100 kilowatt standard generators; another Armington & Sims of 150 h. p. driving a 50 kilowatt reserve generator and one 100 kilowatt; and a third of the same make of 25 h. p. running three generators of the 1885 type, each of 8.5 kilowatt capacity. This makes a total of 1,115.5 kilowatt capacity, or just about 1,500 h. p. The plant is not yet complete, however. When it is the capacity will fall not far short of 1,900 h. p. with the ability to increase it 50 per cent. at any time. The maximum output of the plant so far has been slightly over 700 kilowatts. Steam is supplied to the engines from three boilers of 500 h. p. each and three of 250 h. p. each, making a total at present of 2,250 h. p. Provision has been made for three more boilers of 250 h. p. each. The power house itself is a spacious building with generous elbow room, and has two handsome brick smokestacks each 130 feet high.

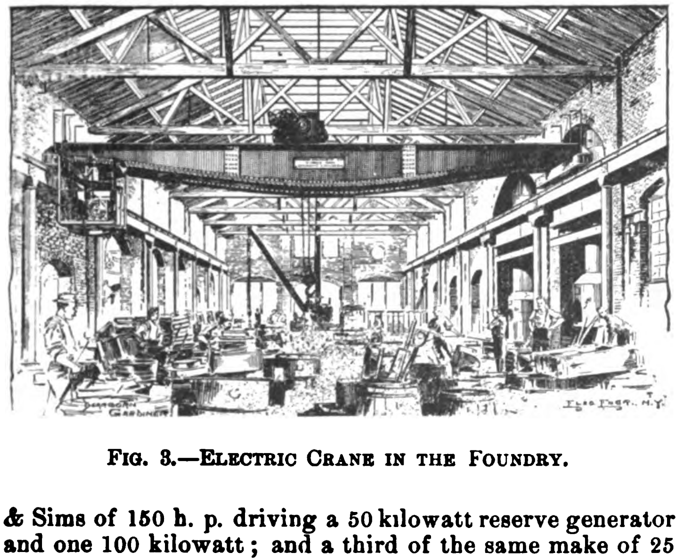


FIG. 3.—ELECTRIC CRANE IN THE FOUNDRY.

IV.

From this central power plant, situated conveniently on the main avenue that runs straight through the Works from the entrance gates, the current is carried to all the various departments. The entire electrical apparatus is to be controlled from two switchboards each 24 feet long by 15 feet high. These boards are arranged one on each side of the central door through the wall that divides the dynamo and engine rooms from the boiler-rooms, and, for easy access, are placed four feet from said wall. The left-hand board contains all the switching and controlling devices for the dynamos, while that on the right hand will carry all the switches, ammeters, safety fuses, etc., for each feeder. Each of the boards is so arranged that all operations can easily be performed by an attendant standing on the floor. From these switchboards the current passes to the different shops over about 10,000 feet of line on the two-wire system, the supply for power being at 250 volts while that for the ordinary lighting circuits is 125 volts. This is exclusive of the interior wiring, but neither inside the shops nor on the outside avenues does one notice any wires except for the overhead trolley system of locomotives. As a matter of fact, the circuits are almost wholly carried in the familiar iron tubes that belong to the Edison methods of undergrounding the wires in cities.

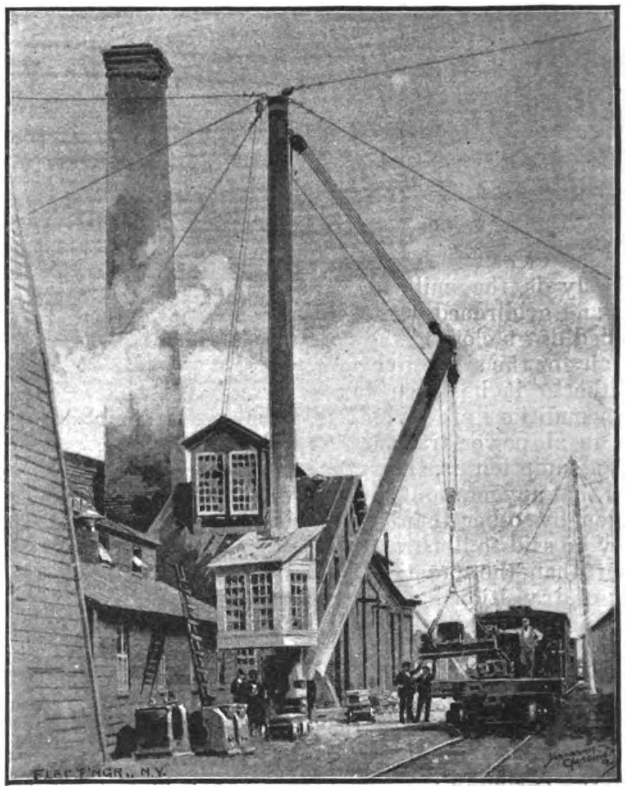


FIG. 5.—ELECTRIC DERRICK AT THE EDISON WORKS, SCHENECTADY.

It is needless to point out that were the power distributed by means of shafting or by engines fed from a ramification of steam pipes, the mechanism of distribution would be much more *en evidence*, and would be much more expensive and cumbersome.

V.

The electric current thus generated and distributed goes to no fewer than 43 stationary motors of the standard Edison bi-polar upright type scattered throughout the Works. These motors are of different sizes. Their total capacity is 1,324 kilowatts, but the demand for current by no means reaches that amount at any time as it is practically an impossibility that in any factory every different machine or tool will be in use up to its limit of capacity at the same moment. A great many of these motors run the lines of shafting to which the various wood-working, metal-working, wire-braiding and other tools and appliances are connected, so that all told the sections of shafting amount to 5,260 feet in the shops, which cover a floor area of 11.84 acres. To put it tersely, just one mile of shafting is run by electric motors at Schenectady. Yet all this shafting is so subdivided and so independent that it is possible to throw on or off 99 per cent. of it without the slightest interference with the remaining one per cent., or without any effect on the central generating plant except in the immediate adjustment of the dynamos to the lighter or heavier

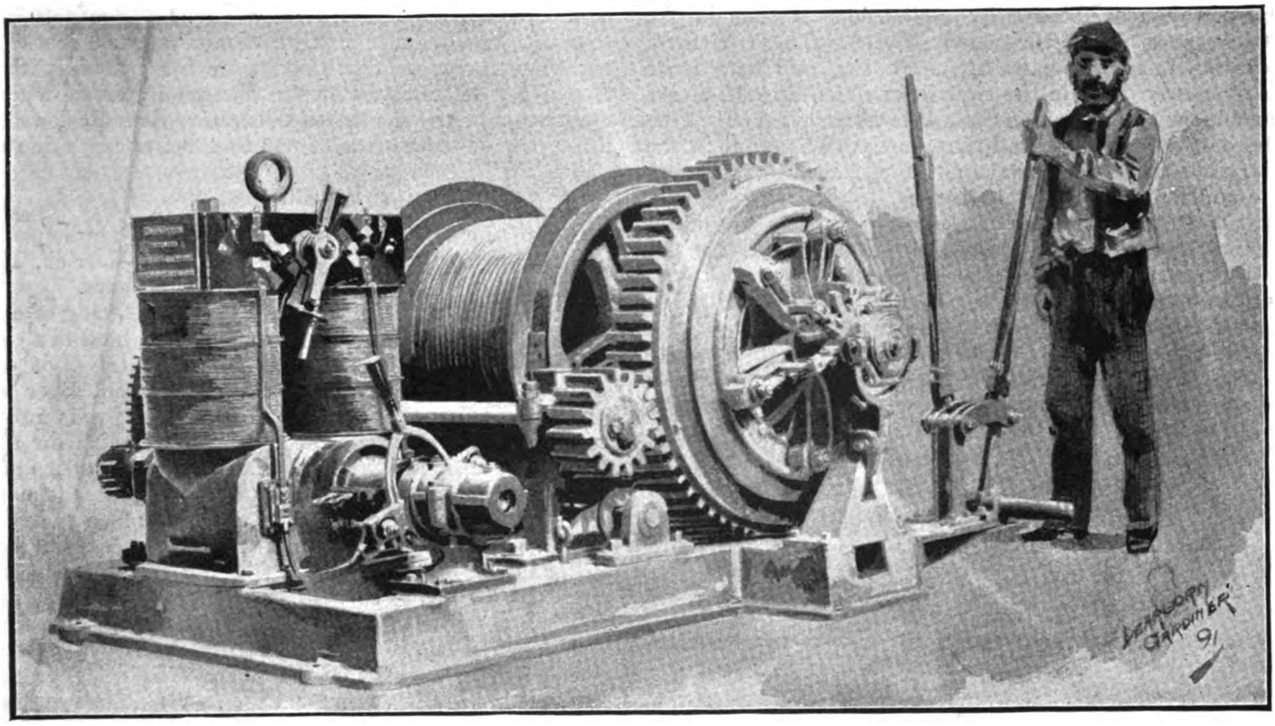


Fig. 4.—Electric Hoist at the Edison Works, Schenectady.

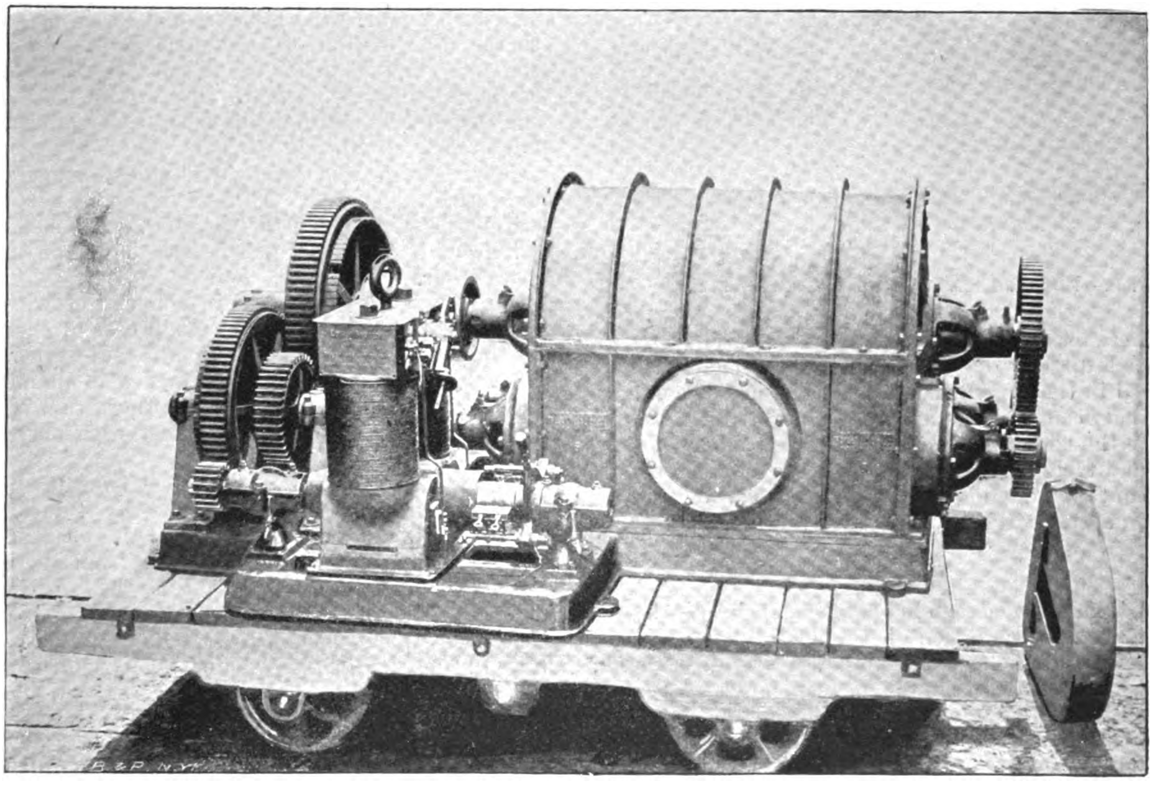


Fig. 6.—Baker Air Blower at the Edison Works, Schenectady.

load. New motors are added daily, as, for example, those in the fixture and appliance shops recently erected.

VI.

One of the most noteworthy applications is seen in the electric cranes, here illustrated, Fig. 3. These perform heavy duty in various parts of the Works, and save large sums of money daily in the expeditious handling of pieces of machinery that otherwise could be transported only with the help of several men, and that slowly. The crane in the foundry has no less a span than 47 feet 2 inches; and that in the boiler shop, 23 feet 10 inches. Both will swing a weight of 10 tons with the utmost ease; all that is required of the workman is a gentle, coaxing pat as he steadies the load down into its desired place. The crane proper consists of two transverse beams mounted on a two-wheeled trolley at either end. These trolleys run on rails laid the length of the shops. The three movements of the crane—traveling, hoisting and transversing—are accomplished with three separate motors, though it is not necessary to have as many, it being possible to operate with one or two motors. This is sometimes done. The motors are located conveniently for each distinct operation, and all are controlled by levers placed in the cage at the side. The use of conducting cables between the cage and the transversing motor is obviated by the use of a board carrying a number of copper strips and fastened on the inside of one of the girders. A sliding contact is made on these strips by carbon brushes attached to an arm carried by the transversing carriage.

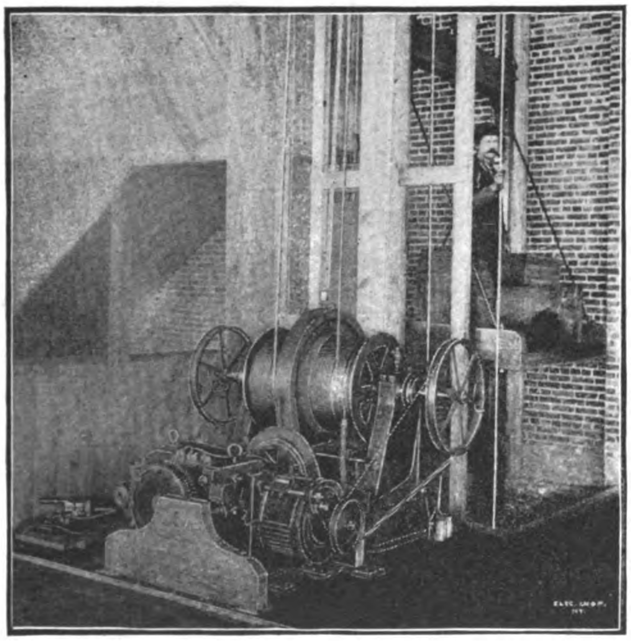


FIG. 8.—EDISON ELEVATOR WITH CONTROLLER.

VII.

The electric hoists to be seen in operation at the Works are a very effective demonstration of the flexibility of electric power. That which is here illustrated, by way of example, Fig. 4, is a sturdy mass of simple mechanism equal to any task that is likely to be imposed on it. The motive power is a 20 kilowatt Edison motor, standing in the same bedplate, and geared through an intermediate shaft to a large clutch gear on the drum shaft. The drum is keyed to the shaft which engages the gear by means of a friction clutch, operated by an upright hand lever; while a similar lever is used to operate the motor switch, connected with a suitable resistance box. The levers are so arranged that the motor can only be started when the clutch is engaged. The drum is provided with a band brake operated by a foot lever, and placed within easy reach of any one standing at the hand levers. One end of the intermediate shaft is provided with a winch. It is a compact appliance, as the cut shows. The bedplate is only about 5 feet, 10 inches square. The drum will wind in one layer 260 feet of five-eighths inch rope. These hoists are being made with positive clutch as well as with the friction clutch shown in the engraving. Such a hoist as that above described will raise 1,500 pounds at the rate of 350 to 400 feet per minute.

VIII.

One of the most novel and interesting appliances seen in the Works yard is the new electric derrick, Fig. 5, swinging heavy loads to and from freight cars.

The derrick is of the ordinary type, consisting of a vertical post, or mast, rotatable on its axis and held in a vertical position by guy ropes from the top. At the foot of the mast, a jib, or projecting arm, is fastened, over which passes the rope carrying the load. The jib is provided with a block and tackle so that there is facility for swinging a load horizontally, as well as hoisting. The iron frame which carries the ordinary windlass attachment used on this type of derrick is removed, and its place taken by a similar iron frame of Edison make which carries an electric motor in combination with a winding drum. This frame is arranged so as to carry a standard "1885" type motor, which is fitted with a special bedplate and an extra pillow block. A worm on the armature shaft drives a worm wheel, fastened on the end of a short intermediate shaft, which is held in position by a special angle bracket bolted to the main frame. Upon the other end of this intermediate shaft, a bevel pinion meshes into a bevel gear wheel keyed on the intermediate shaft of the hoisting drum. The drum shaft is provided with a large gear wheel which engages with a pinion on its intermediate shaft, as is usual in this form of hoist. The motor is compound, but is provided with a specially wound series field, so that it may be started up by a regular starting and reversing switch without the intervention of resistance coils. As regards the connecting cables, it has been found the best practice to put them under the ground, allowing the end of the iron tube through which they are taken to come up by the side of the mast, so that it projects about a foot above the ground. From this point a flexible connection can be made with the switch. This arrangement keeps the wires entirely out of the way for working. A housing frame is built around both motor and switch to give protection from the weather.

The following particulars in connection with this particular derrick may be of interest in case of changes being contemplated in steam derricks of the same type. The mast is of wood, 50 feet high, and 26 inches in diameter at the bottom. The diameter of the winding drum is 18 inches, and about 160 feet of $\frac{3}{4}$ inch steel rope may be wound about it.

The motor housing frame is 7 feet from the ground, the size of its base being 6 feet 6 inches by 4 feet. It has a slanting roof, the extreme height being 9 feet 5 inches, and the least height 6 feet 5 inches from its base. The reversing switch used for controlling the hoist in operation is placed 3 feet 6 inches above the ground, so as to be easily accessible. This derrick is built to deal with loads up to 12 tons, and is operated by an $8\frac{1}{2}$ kilowatt motor—a little over 11 h. p.

IX.

One of the problems of mill and mining work is that of ventilation. Very often its solution is neglected because of the difficulties connected with the operation of the apparatus, but where the electric current is available, as at the Edison shops at Schenectady, there is no trouble whatever. Here is a view of a Baker air blower, Fig. 6, encountered in our peregrinations and it strikes one immediately that the combination must be a great boon not only in mills and mines but in iron smelting furnaces, tunnels, &c. The blower before us is a simple apparatus. Its working parts consist of three turned and balanced drums so arranged that their centres lie at the corners of an equilateral triangle. The motor driving it is geared through an intermediate shaft with the upper drum which does the actual work of blowing and exhausting, the lower drums simply acting as valves, their relative positions being maintained by the gears at the end. These gears are protected by a cast iron cover. On the intermediate and upper drum shaft they are fitted with wooden teeth, so as to avoid noise. In the particular combination under notice the armature shaft of the motor runs 10.5 times faster than the lower shaft. Running free, the blower at a motor speed of 1400 revolutions per minute will pass 3300 cubic feet of air in that time.

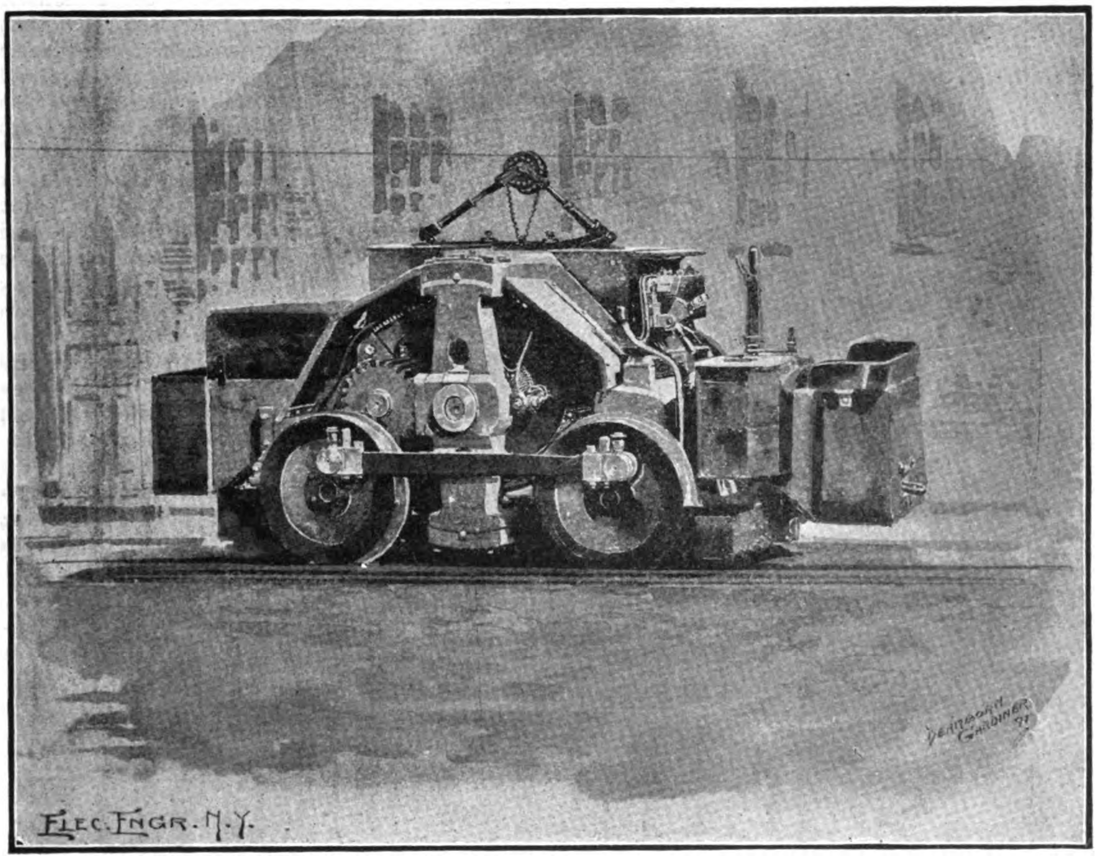

ELEC. ENGR. N.Y.

FIG. 7.—LOCOMOTIVE FOR HEAVY TRACTION.

X.

The applicability of the electric locomotive to mill or mining work is well illustrated in the motor seen under test by the writer and here illustrated, Fig. 7. As was the case with every other piece of mechanism about the Works, it derived its power from the central station. It is obvious that both steam locomotives and the cable are undesirable and even objectionable around a mill or factory. The cable of course is always traveling in the same direction, so that a mill cable car must always be headed one way. Moreover the cable system under such conditions proves extremely expensive. With regard to steam locomotives, it may be pointed out that the cost of handling and maintenance is heavy, that there are the features of smoke and dirt to contend with, and that in mills where fabrics are treated there is risk of setting fire to the surrounding materials, whether wool or cotton. The use of a steam locomotive indoors is, in fact, not a prospect that one contemplates with equanimity.

On the other hand, the electric locomotive is easy to govern and manipulate, is quiet and cleanly, and is compact for its power, while it runs freely back and forth in either direction on the same track at the will of the attendant, who may be and often is the budding electrical genius to be found in well nigh every American factory—a mere boy of 15 or 20. The locomotive here shown is of a very solid and serviceable type, designed specially for mining work but easily applicable to any class of factory employment, whether within the walls, or on the tracks communicating with the main lines of steam railroad. This locomotive will handle a train of 120 tons at a speed of from 7½ to 12 miles an hour. The motor is of the four pole type, with magnets and armature protected from injury by iron casings. The power is transmitted from the armature to one axle by heavy gears and the wheels on this axle are joined to the others by connecting rods, as on a steam locomotive. The track gauge is 3 feet 8 inches. The speed is governed by a special controlling switch, and the seat of the driver is so arranged that he can easily look in either direction.

XI.

Elevator service is a very important matter in most factories, and often necessitates individual outfits. But with a central electric power plant, it is easy to run any number of elevators in buildings widely scattered. There are two elevators being installed in Schenectady, in the No. 23 building, and one is already in daily use, Fig. 8. It consists of a Graves direct hoisting elevator operated by a slow speed 15 H. P. motor, and the motion of this elevator is governed by a controlling device such as that used on Edison railway motors. It is composed entirely of iron, mica and brass, so that although designed for a steady current of 15 amperes, it can be run for quite a time on very much higher currents and attain quite a high temperature without danger of burning out.

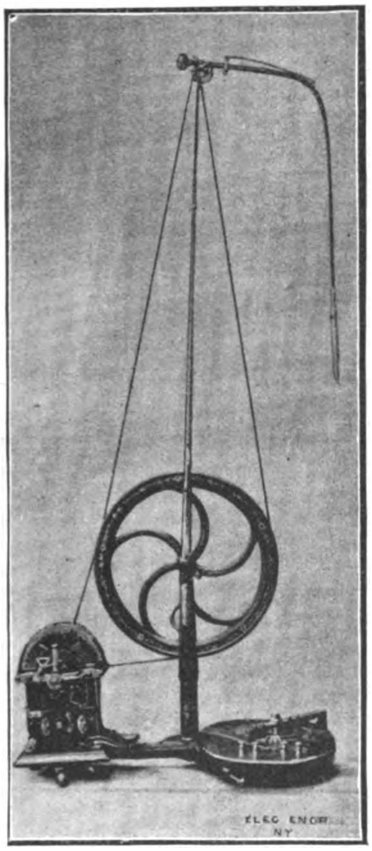


FIG. 9.—EDISON DENTAL DRILL.

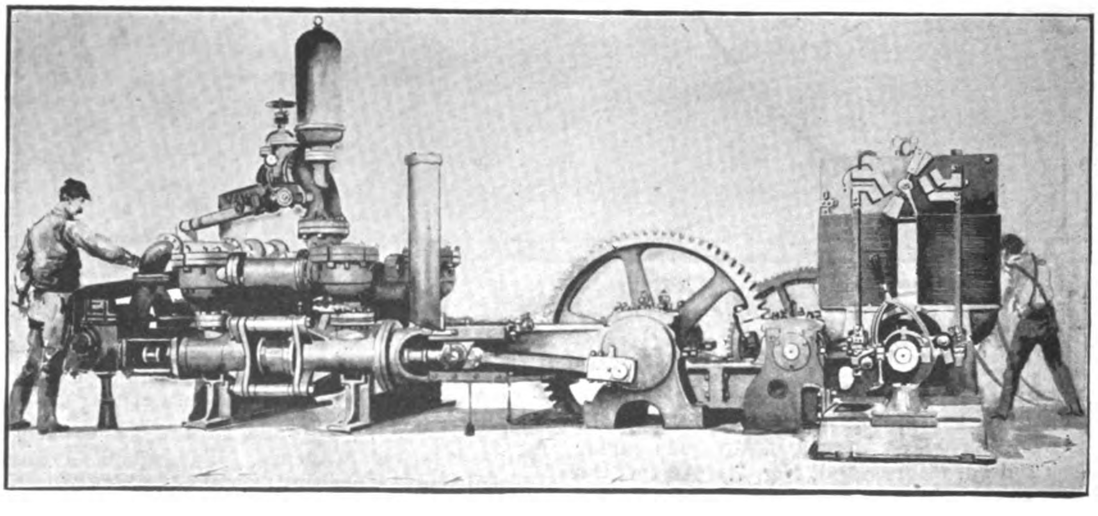


FIG. 10.—KNOWLES PUMPS COUPLED WITH EDISON MOTOR.

The second elevator is an hydraulic elevator consisting of a pump operated by means of belting from a motor. In this case the Edison Co. have adopted belting on account of their being able to produce thus a noiseless combination suitable for office, building or hotel purposes. The pump feeds directly into the high pressure cylinder into which the piston carrying the elevator car moves. The operation is as follows: If the car is to be raised from one floor to the other, the motor is started by means of the controlling device mentioned in connection with the other elevator. The pump then forces water into the cylinder at a pressure of 80 lbs. to the square inch. This water expels the piston and in this manner lifts the elevator. On reaching the next floor the motor is stopped by means of the controller, and when it is desired to descend, the operator on the car opens a valve which allows the water to escape from the cylinder into a tank. The same water is used again when the elevator is required to ascend on its next trip.

In both cases the controlling devices operating the motor are controlled by the man on the elevator by means of ropes passing through the elevator in the same manner as is done with any other elevator, or, in other words, by pulling the rope up or down, the motor is stopped or started, and in the case of the hydraulic elevator, the valve allowing the water to escape from the cylinder is opened and closed.

XII.

It would be difficult to match the demonstration of the range of electric power given in the fact that the central station at the time of our inspection was furnishing current at one and the same time to the 120 h. p. motor running the big Knowles double mining pump, and also to the tiny little one-twelfth horse-power motor operating a dental outfit. Surely the force of contrast could no further go. Details with regard to the pump are given in another section of this article. With respect to the dental drill, Fig. 9, it may be here stated that they take the ordinary dental drill and remove the foot lever and crank, making use of the old pivot to fix a strip of steel upon which can slide the $\frac{1}{12}$ h. p. motor, arrangement being made to clamp it in any position so that the belt which is placed around the fly-wheel and pulley of the motor can be kept at any desired tension. The motor, therefore, occupies one of the legs, and the other two legs are utilized to support the reversing and resistance switch. The handle of the switch is of special construction so that the operator can use it as readily as the treadle. It is arranged to project over the edge of the resistance coil, and the operator can, by a slight movement of his foot, switch it over to either side, so that the motor runs in either direction at will. If the arm is in the central position, the current is off. If between the central position and one side, the motor runs in one direction, but not at full speed. Catch clips are arranged so that the operator can tell immediately he has reached either the "off" position or the "full on" position on either side. He can also obtain four different speeds under full speed. The connections of the apparatus are very simple. The motor is designed to run on 125 volt circuit, so that it can be used on a local electric light circuit. A wall socket is fixed near the dental chair and a flexible cord led from this to two terminals on the motor.

Yet this was hardly all, for a large number of the small Edison motors may always be seen at the Works, as they were then, going through their paces, prior to shipment. It would be easier in these days to tell what small electric motors *don't* do than what they do, as the general availability of current has found them endless occupation in the trades and industries that are fostered by our great modern cities.

XIII.

Another interesting piece of machinery that we chance upon in going our rounds is an electric pumping outfit, just referred to, intended primarily for use in mine work, but useful also in many other situations. This combination consists a 25 h. p. series motor and a Blake double-acting pump, upon the same bedplate. The armature shaft of the motor is connected by a worm driving a large gear wheel to a pair of crank discs one on each side of the machine. Wrist-pins, placed at an angle of 90° to each other, carry the connecting rods operating the plungers of the double-cylinder pump. Each pair of plungers being connected together by outside rods, work together like one plunger; and the connection with the crank discs being at an angle, one pair of plungers is drawing while the other is forcing water,—thus making them double acting. The size of each cylinder is 5 inches diameter by 12 inches length. The regulation of the speed of the driving motor is effected by commutation of the field-coils, which are divided into three sections. If we wait long enough we can see the machine put through its paces. Taken, thus, at an off-hand test, to satisfy our casual curiosity, it will be run at various speeds. At 35 strokes a minute and a pressure of 75 lbs. per sq. in. it will deliver 143 gallons per minute a height of 173 feet. At 26 strokes and 175 lbs. pressure, it will raise 106 gallons a height of 404 feet. Of course in actual work, the size of pipe and number of bends determines the delivery, but this is evidently good work.

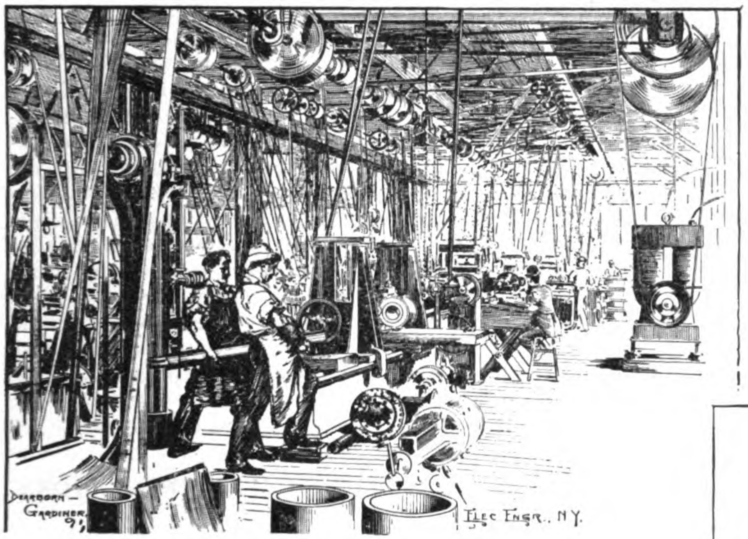


Fig. 14.—View in One of the Machine Shops.

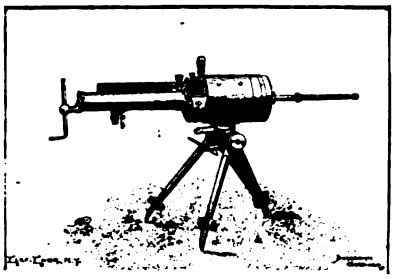

Elec Engr. N.Y.

Fig. 11.—Edison Reciprocating Drill.

Interesting as is the performance of the pump above mentioned it falls short, in regard to the magnitude of the work done, to the pump here illustrated, Fig. 10, and which was under trial at the time of our visit,—being run from the central station already described. This pump has now gone into the Poorman Mine of the Cœur d'Alene Silver Lead Mining Co., near Burke, Idaho, where the Edison Co. has installed a plant of between 400 and 500 h. p. for a variety of mining operations. It consists of two Knowles double-acting centre-packed, outside plunger pumps, in combination with two 10 inch double-acting suction pumps, and is driven by a 100 kilowatt 250 volt compound wound Edison motor of the 1885 type. As arranged for the test, both suction and plunger pumps drew from and discharged into the same tank. The suction pump worked against a 7 foot head corresponding to the pressure of 3.08 lbs. per square inch, and the plunger pump against a 10 ft. head, which corresponds to the pressure of 4.4 lbs. per square inch. The diameter of the cylinder of the suction pump is 10 inches, and the piston rod is 2¾ in. in diameter, so that we have an effective working piston area in the suction of 75.57 square inches. The diameter of the cylinder of the plunger pump is 9½ inches, and the shaft being 2¾ inches in diameter, after deducting twice the area of the piston rod, we obtain the effective working area of 64.943 square inches. The pump has a capacity of 500 gallons, which it can deliver to a height of 550 feet. The efficiency of the combination was tested very carefully and found to be between 75 per cent. and 80 per cent. The combination no doubt is one of the most efficient of this character made so far. It is at work in the Poorman Mine, giving excellent satisfaction, being capable of pumping the mine dry within ten hours.

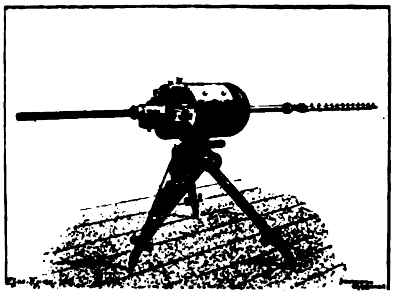


Fig. 12.—Edison Rotary Drill.

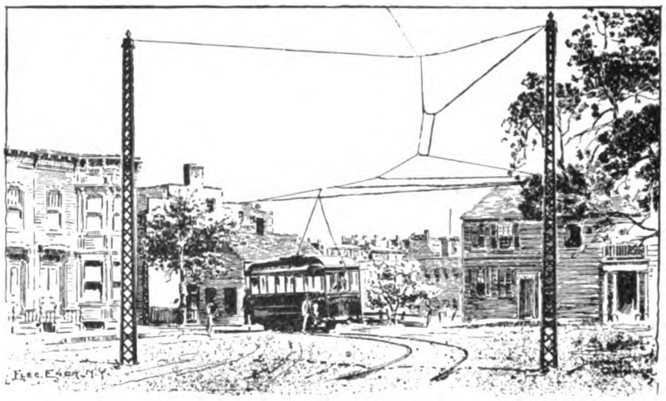

Elec Engr. N.Y.

Fig. 13.—Edison Electric Railway at Schenectady.

XIV.

A special feature of electric mining work is the use of drills, and of these several are usually under test at the Works prior to shipment to their destination in some far-away mining camp. We have shown a couple of them here, Figs. 11 and 12, as seen vigorously demonstrating their ability to "knock the stuffing" out of any obdurate material opposed to their Sullivanesque attack. The Marvin electric percussion drill strikes about 400 to 450 blows a minute, the number of blows being regulated to suit the character of work being done. It is capable of drilling at an average rate of 2 inches per minute in hard granite; and has reached a maximum speed of 4 inches in hard granite. It can drill to a depth of 20 feet, starting with a 3 to 3½ inch starter, and bottoming with a 1⅝ to 1¾ inch drill. It is practically impossible to burn out the coils on account of the incombustible insulation material used. A large number of these drills have been sent out and are doing work in phosphate mines, gold and silver mines, limestone quarries, slate quarries, granite quarries, and a number of them are also used by contractors doing work for railroads in the West.

Regarding the diamond drill, it may be stated that the company are building two sizes: One for deep work up to 650 feet, and the other for lighter work up to 250 feet; the first to be used for outside work principally, and the latter intended more for inside mining work, and such places where a light, portable drill of not too large a capacity is required. These diamond drills embody all the latest improvements that have been made for this kind of apparatus.

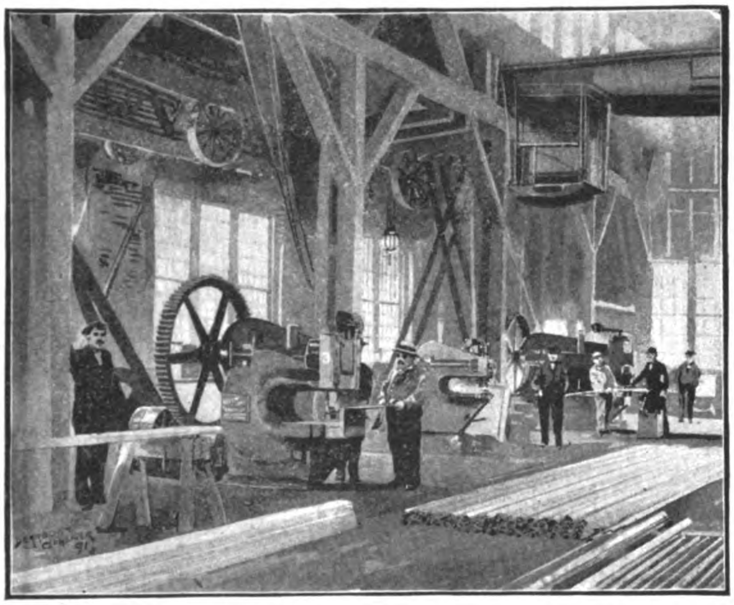


FIG. 15.—BOILER SHOP RUN BY MOTOR.

XV.

Perhaps one of the most interesting features in connection with this power plant is the electric street railway. A modern central station is as universal a basis of supply as a Macy or a Wanamaker store. The want is no sooner created or known than it is met; and it is only natural that where power is so flexible and available new uses should be found for it. It is obvious that in a great many industrial centres, a line of electric railway serving as a bond of union between the residences of the workpeople and the factory in the heart of the town or in a remote suburb, must often be very much of a convenience. In fact it will frequently prove an inestimable boon. At Schenectady, the growth in the population has led to a gradual development of the city away from the low-lying, swampy old sections up to the healthy hills that look down on the Mohawk Valley and the Erie Canal. The new road penetrates on one hand the crowded quarters of the city proper and on the other is cutting its way into the newer residential districts up the hills. Our sketch, Fig. 13, gives a view of the road at one of its sharpest curves. It is evident that under such conditions as have been mentioned above, an electric road can be run very economically, and it is certainly one of the striking proofs of the all-round utility of electricity that the same plant which thus at Schenectady furnishes the workmen and their machines with power, handles freight, swings the cranes, pumps, ventilates and cools, should also be the means of transporting the employees to and from their work.

XVI.

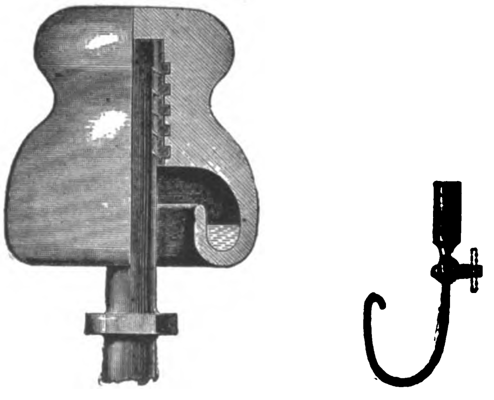
There are of course several applications that can be, and are, made of electric power in and around a factory that even this vast plant at Schenectady does not illustrate. Such, for example, are the special classes of machinery that are to be encountered in shoe factories, printing offices, tailor shops and the like; but it is remarkable how many hundreds of distinct tools in the various lines of wood and metal working belong to the modern electrical factory and are to be seen at Schenectady in full swing and with the utmost success, as evidenced by Figs. 14 and 15. There are, moreover, the peculiar appliances and apparatus necessary in the making of insulated wires and cables, and the manipulation of rubber and cotton or silk. Altogether, the plant justifies many of the claims that are being made so persistently and energetically to-day for the general use of electricity as *the* means of distributing power in mills and factories, and it is very satisfactory to learn that this demonstration at Schenectady is as successful as its scale is generous. So much a matter of fact is it already, that nobody in the Works stops to think about it or comment on it; and any inquiry in any one of the forty or fifty departments elicits the same answer as to complete satisfaction. And yet less than ten years ago, the Comte du Moncel in his book on "Electricity as a Motive Power" said, with the feeling that people would hardly believe him: "When we reflect that now we are enabled to transport to almost any distance a force of several horse power by a wire which could easily be passed through a keyhole without any visible movement or change in its appearance, imagination itself is stupefied, and we ask ourselves if it is not magic!" But it is not magic, it is plain, straightforward engineering.

NOTE ON RESULTS WITH PORCELAIN INSULATORS.

BY

Henry Stott

IN pursuance of the discussion on Porcelain versus Glass Insulators, now being carried on in THE ELECTRICAL ENGINEER, perhaps the experience of the writer some years ago with the particular form of porcelain insulator known as the Johnson & Phillips Fluid Insulator, may be interesting.



THE JOHNSON & PHILLIPS FLUID INSULATOR AND FILLER.

This insulator is made in various forms of brown or white glazed porcelain of the best quality, the mechanical strength being all that could be desired. The groove shown on the inside of the insulator in the figure was filled with a resinous oil, from a siphon, after the insulator was fixed on the pole or roof standard, and the cable then attached. The mains were for the greater part insulated with rubber, but over two of the eight miles were entirely innocent of covering of any description. The 2,000 volt cables were led into the various buildings through porcelain leading-in tubes and then to a high-tension switch, fuse and converter. The fuse bases were made of slate, but this was afterwards discarded and marble substituted on account of the leakage caused by the hygroscopic slate. Tests for insulation were taken every morning, and, as may be imagined, quite a large proportion were taken under the worst atmospheric conditions possible, namely, during that fine penetrating rain so common in England, which no rubber coat could long defy, as the writer remembers without much pleasure. Under this ordeal the insulation test used to give about 60,000 ohms. This, of course, included the leakage from switches, fuses and converters, as well as from the insulators. Deducting 10 per cent. from the leakage for the former, which under the circumstances would be a very conservative estimate, this gives 66,000 ohms as the absolute insulation resistance of about 180 insulators, or 11.8 *megohms each, under the worst climatic conditions imaginable.*

These figures, of course, are approximate only, but no account having been taken of the leakage due to leading-in tubes, this certainly may be looked upon as under, rather than over, the true figure. No breakages occurred except those due to purely mechanical causes which no insulator could be expected to withstand. The cost, including oil, was about 25 cents each. I have no figures at hand, giving tests of glass insulators under similar circumstances, and it would be interesting if Mr. F. W. Jones would kindly give us some information from the test books of the Postal Telegraph Co. for comparison. Mr. Jones' appeal to the porcelain manufacturers should be earnestly backed up by lighting and power companies, especially by the latter, as the day is not far distant when the subject of the transmission of power over long distances at, of necessity, high pressure, will leave the field of speculation and calculation for that of practice and fulfilment, and compel them to look for a higher class insulator than glass.

ON THE LAW OF HYSTERESIS.[1]—II.

BY CHAS. PROTEUS STEINMETZ.

The calculation of the readings was done in the following way:

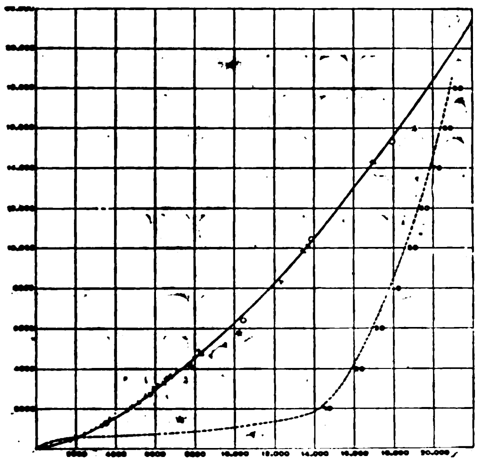


FIG. 1.

After applying the corrections for self-induction of instruments, resistance and speed, the readings were reduced to lines of magnetic force per square centimetre B and consumption of energy by hysteresis per magnetic cycle H, in ergs.

Then the results were plotted on cross-section paper and if any value was found to be very much out of the curve connecting the other values, it was stricken out as evidently erroneous, not considering it worth while to determine whether it was a wrong reading of any one of the instruments or a mistake in the calculation.

Then from the other values of B and H, under the supposition that H were proportional to any power x of B, $H = \eta B^x$, this exponent x was determined.

This value x will be seen always to be so near to 1.6 that 1.6 can be considered at least as first approximation to x.

Then, under the assumption that $x = 1.6$, $H = \eta B^{1.6}$ the coefficient η was calculated, and the equation $H = \eta B^{1.6}$ plotted in a curve, as given in the figures, and the observed values of H drawn in and marked.

From the curve were taken the calculated values of H, corresponding to the observed values of B, the difference $H_{calc} - B_{obs}$ determined, and expressed in per cents. of $H_{calc.}$

These values were given in the tables and shown in the curves.

I.—*Magnetic Circuit of the Westinghouse Converter.* (FIG. 1; TABLE I.)

On this magnetic circuit tests were made with the frequencies of 28, 36, 137 and 205 complete periods per second, and the results found to agree very well with the law of the 1.6 power, as the following table shows:

TABLE I.

Frequency. $N = 205$ complete periods per second.

B	H obs.	H calc.	$H-H$ calc—obs.	%
1790	376	400	+24	+6.0
1990	463	460	− 3	− .7
2380	585	610	+35	+5.7
2620	735	720	−15	−2.1
3060	893	920	+27	+2.9
3390	1054	1100	+46	+4.2
3660	1297	1240	−57	−4.6
3710	1288	1250	−38	−3.0
4620	1822	1800	−22	−1.2
5070	2024	2070	+46	+2.2
4990	2034	2010	−24	−1.2
5910	2698	2620	−78	−2.8
6100	2844	2750	−96	−3.5
6550	3039	3080	+41	+1.3
7290	3673	3640	−33	− .9
8050	4341	4300	−41	−1.0
8320	4410	4530	+120	+2.7
8240	4561	4460	−101	−2.2
		av:	± 47	=±2.7

where B = the maximum magnetization, H the loss of energy by hysteresis.

Exponent of power, derived from tests: $x = 1.6012 \sim 1.6$. Coefficient of Hysteresis: $\eta = .002434$; hence, theoretical curve, $H = .002434 B^{1.6}$.

From these 4 sets of readings, we get the following results:

TABLE II.

	Frequency, in complete periods per second: N	Number of readings.	Exponent of power, found by tests: X:	Coefficient of Hysteresis, found by tests: η:	Magnetization B covered by the observed values: From:	To:	Average difference between observed values of hysteresis H, and values calculated by the law: $H = \eta B^{1.6}$:
1.	28	4	1.6111	.002410	3510	17,940	±2.3%
2.	36	5	1.6476	.002315	7090	19,840	±4.4%
3.	137	10	1.5887	.002438	4000	13,750	±2.0%
4.	205	18	1.6012	.002434	1790	8,240	±2.7%

Therefrom we derive the average, by giving to each value as weight the number of readings, where it is based upon: $x = 1.60513 \sim 1.6$; $\eta_i = .0024164$. Hence: $H = .0024164 B^{1.6}$.

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[1] Abstract of a paper read at the sixty-third meeting of the American Institute of Electrical Engineers, New York, January 19th, 1892.

Letters to the Editor.

THE LEONARD LAW OF MOTOR EFFICIENCY.

REFERRING to Mr. C. O. Mailloux's article under the above title in the issue of THE ELECTRICAL ENGINEER of January 13, I beg leave to offer the following reply. In his article Mr. Mailloux says: "It was in 1882 that Marcel Deprez first accomplished what Mr. Leonard now claims as his discovery or invention. * * * * * His experiments have been freely quoted, among others, by Kapp (Elect. Transm. 3d ed. p. 89), and also repeated by others." (Thompson Dyn. Elec. Mach. 3d ed. p. 539).

Mr. Mailloux makes a serious mistake in assuming that the contents of such standard works as those he mentions are unknown to others than himself, and does me an injustice (I trust unintentionally) by making it appear to the casual reader that I have put forth the most extravagant claims.

In fact the above references which Mr. Mailloux gives were well-known ones to myself and my patent lawyers before my applications were filed, and were carefully considered along with many others by the Patent Office examiners before they passed favorably upon my applications.

I cannot doubt that Mr. Mailloux's familiarity with the subject made him aware of the fact that the references he cites apply only to a series motor operating under a constant load.

Thompson (p. 539) is extremely careful to limit his statements to a series motor in saying: "With the same load the same current whatever the speed."

Kapp is equally as careful (p. 89) to limit his statement to constant current in saying: "If the current is constant the speed must be proportional to the electromotive force."

When, in considering motors whose torque and speed must both be varied, I stated the law of efficiency as being,

"Vary the voltage as the speed desired,
Vary the amperes as the torque required,"

and said: "In other words, make the speed dependent upon the voltage only and independent of the current, and make the torque dependent on the current only and independent of the voltage," I did not suppose I left any doubt as to my meaning that the volts should be varied *directly* in proportion to the speed desired, and similarly the current as the torque. Yet Mr. Mailloux evidently interprets me incorrectly, for he says:

"The fact is the amperes vary as the torque in all forms of motors *though not in the same way*."

Any number of writers have stated that with a shunt motor on constant E. M. F. the torque varies as the current; also that within a series motor on a constant current the speed varies as the volts.

Yet, evidently with neither of these motors could we vary both the voltage as the speed and the current as the torque; that is, while we could operate efficiently at constant speed with the shunt motor and at constant torque with the series motor we could not with either operate efficiently when both the speed and torque vary. It will be noticed that it is the constant field which we obtain in the shunt motor by constant E. M. F and in the series motor by constant current, which enables us to secure the exact relations between torque and current in the one case, and speed and volts in the other. Evidently this constant field cannot be maintained if we vary the volts on a shunt motor or the current on a series motor.

The use of the separately-excited field, which my method employs, gives perfectly exact relations between current and torque in the general case of performing work—*i. e.*, when both speed and torque are variable.

Thompson, in treating "Magneto motor and separately excited motor" (p. 569) gives one page to the subject, treating it briefly under two cases. Case I, Volts constant; Case II, Current constant; but does not even mention the general case when both are variable. Kapp does not treat the subject of separately-excited constant field motors at all.

That Mr. Mailloux has failed entirely to understand what my method accomplishes is clearly shown by his statement: "I do not regard a constant field as a condition *sine qua non* for accomplishing what Mr. Leonard's method does. A series-wound motor, used in place of his separately-excited motor, would operate quite as satisfactorily in most cases, and more so in many cases."

I realize fully and admit freely that, with the existing system of distributing electricity the series motor is frequently cheaper, simpler and sufficiently satisfactory; but it seems evident that if we can keep the field constant and then supply electric energy, which shall always be exactly proportional to the mechanical power produced and so that every speed will be an automatic one, independent of the load, it will be difficult to secure a more satisfactory result.

The immediate future will bring forth a system of distribution which will make it possible to operate under my method with all the simplicity of a constant-potential system and yet with perfect efficiency and control of speed under any variation of speed or torque.

Regarding the illustration I gave of the three-car train having six motors, Mr. Mailloux pronounces my statament "absurd." Undoubtedly his misstatement of my statement is so, for he makes the mistake of considering the current of the six armatures in connection with the volts of one, which it seems impossible that any reader should do, except with an endeavor to make my statement appear "absurd."

I regret that my method should have been so misunderstood by Mr. Mailloux, and trust that I have made it evident that the law and method I stated are really quite specific and limited and do not claim all the past discoveries of other workers in the field, as Mr. Mailloux mistakenly supposed.

H. WARD LEONARD.

NEW YORK CITY, Jan. 19, 1892.

ANOTHER WAY OF SAVING POWER UPON ELECTRIC RAILWAYS.

IN your issue of January 13th, I notice with interest Mr. Marple's remarks upon the power lost to an electric railway system consequent upon poor rail connections; the additional wear and tear upon machinery, and heating of motor parts due to the unsteady current resulting. Mr. Marple's observations upon the necessity of having good electrical connections between car wheels and rails are, at the present stage of electrical railway history, axiomatic. The suggested remedy is, we believe, good but unnecessarily expensive and troublesome. To keep such a contrivance in good order, to use it frequently and at the proper time requires the whole attention of a number of men. Its effect is not permanent, moreover, and the tracks, soon after the passage of a watering cart, resume the natural condition, dust covered.

What is needed is a device that will thoroughly clean the rails afresh for each car; that will require but little attention and cost but little money. Such a device is found in the strong, durable track brooms now used upon many street car lines and even upon steam roads where the latter accommodates suburban traffic. The brooms are attached to the car trucks so as to rest upon the rails. A properly-constructed broom, well placed, will sweep every particle of dust, sand, stone or dirt of any kind from the track, leaving a clean and perfect electrical connection with the car wheels. It is impossible for dust to settle upon the rails between the times of the passage of the brooms and wheels, and however dirty the rails may have become between cars, they are perfectly clean as the wheels of each car pass over them. Where-ever on the route a car may be, there also is a clean track. Brooms are cheap; they cost little time or money. Once properly adjusted they "fill the bill" as a perfect track cleaner.

W. R. MASON.

CHICAGO, ILL., Jan. 19, 1892.

IRON ROOFS IN THE OIL CITY, PA., STATION.

IN regard to the condensation from iron roofs, I would say that our building is brick, 100 x 60 ft., with a corrugated iron truss roof. Our experience warrants us in saying that they are not a success. Ours only bothers us on very cold nights when the thermometer registers near zero, and to obviate that we have to keep the windows down or rather open at top to prevent any melting of the frost or condensation that adheres to the under side of the roof. As we do not run a daylight circuit, we protect our dynamos with covering during the day and freeze during the night. We are arranging now to have a waterproof covering made that we can swing and hang over our dynamos during the night and drop down on them during the day. Iron roofs may be all right in the torrid zone, but in our latitude they are certainly a failure.

OIL CITY ELECTRIC COMPANY,
J. H. PAYNE,
Manager.

OIL CITY, PA, Jan. 25, 1892.

QUICK RECOVERY OF A BOSTON STATION FROM FIRE.

WE are happy to say that although the fire completely destroyed our Ferdinand street station with a dynamo capacity of 1500 lights, at 3:30 o'clock A. M. on Saturday morning, we were able on Saturday night to burn all but 350 lights out of 3200 arc lights as well as all our incandescent lamps and all our power business. Everything was burning that usually burns on Sundays, and to-night we are happy to say that every light in the City of Boston is burning with the exception of a very few City lights, which instead of starting on time at 5 o'clock, will be started when our day commercial lights are thrown off at 6 o'clock, and practically we are burning to-day every light in the City of Boston that we were burning before the fire on Saturday morning.

We consider this as good as any other fellow could do, but not if he went to bed as people do in other business, though never in the electric light business.

F. A. GILBERT,
President Boston Electric Light Co.

BOSTON, MASS., Jan. 25, 1892.

PLANS FOR HOTEL BELL WORK.

HAVING read Mr. Armstrong's article in your issue of Dec. 23 and also Mr. Miner's criticism on the same, I think Mr. Miner overlooks one very important point, viz.: The voltage on open circuit, by using resistance, remains the same as the street circuit, which I do not think safe to introduce into bell wiring.

Also, an ordinary vibrating bell, used as Mr. Miner suggests, will set up an arc at the contact points without ringing the bell.

Mr. Armstrong's is the best of all plans that I have seen, and I expect to utilize it with one improvement, viz., using only one machine with two windings on the armature and two commutators, making a combined motor-dynamo.

J. CRAWFORD BARTLETT.

PHILADELPHIA, Jan. 26, 1892.

IRON ROOFS IN A NEWARK, DEL., DYNAMO PLANT.

THE trouble with the roof of our church organ factory dynamo plant was caused by condensation of moisture upon the inner surface of the sheets of galvanized iron composing the roof of our engine-room, when the weather was frosty, producing a drip which endangered the dynamos, &c.

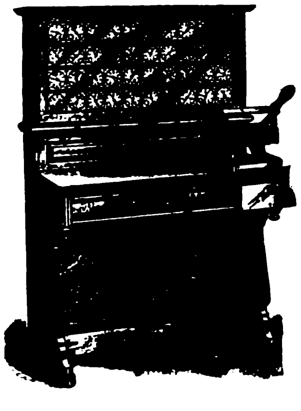
We removed the iron sheets, covered the building with 1 inch hemlock boards and roofing paper, and then replaced the sheet iron as before. This arrangement has given perfect satisfaction. We used tarred roofing paper.

THEO. C. KNAUFF & CO.,
By RUFUS STEWART.

NEWARK, Del., Jan. 26, 1892.

Society and Club Notes.

THE HOLLERITH CENSUS APPARATUS AT THE ELECTRIC CLUB.



A VERY interesting and unusual entertainment was given at the New York Electric Club last week on Thursday, January 28, when Dr. Herman Hollerith, of Washington, member of the club, exhibited his highly ingenious apparatus for counting and tabulating census data. It will be remembered that a description of the system and apparatus was given in these columns on November 11, 1891. Dr. Hollerith brought with him a complete set of appliances, including the "keyboard" and "gang" punches, for stamping holes in the cards, one of which serves for each person; the counting machines, sorting boxes, dials, registering press, tin cases for cards, schedules, tabulation sheets, etc. He also showed one of the old Seaton machines used in the census of 1880. The exhibition was preceded by a brief explanation of the apparatus and the principles involved, after which Dr. Hollerith and his assistant ran a number of cards through the machine. Altogether the exhibit was one of the most interesting that has been made at the club, and it was greatly enjoyed by all. Mr. C. R. Huntley president of the National Electric Light Association, presided, and took occasion to call attention to the use of the machine in tabulating the endless data that Mr. A. R. Foote was wringing out of central station lighting and railway companies.

REMINISCENCES OF LINCOLN.

FEBRUARY 12 is Lincoln's birthday, and in order to celebrate appropriately that interesting occasion, the New York Electric Club has arranged for a special entertainment. Mr. A. B. Chandler, president of the Postal Telegraph Cable Co., who was near Lincoln through the long struggle of the Civil War as a military telegrapher, and who possesses many memorials of the great President, will give a lecture entitled "My Reminiscences of Lincoln," and the lecture will be interspersed by war songs and other melodies given by the well-known Brunswick Quartette.

NATIONAL ELECTRIC LIGHT ASSOCIATION.

MR. C. O. BAKER, JR., the chairman or "master" of transportation for the association, makes the announcement that he has received official notification from the Trunk Line Association, the Central Traffic Association and the Southern Passenger Association, stating that they have granted from points in their territory a fare-and-a-third rate to Buffalo, on the certificate plan, to cover the time of the Convention in February.

Secretary Porter announces that in compliance with the wishes of a majority of the members, in regard to holding an exhibition in connection with the Buffalo meeting, it has been decided that no exhibit will be held under the auspices of the Association. This, however, will not interfere with any arrangements which individual members may wish to make for having a display of goods at the hotel, as has been the custom heretofore.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.

THE 12th annual meeting of this Society was held in its rooms in Pittsburgh, on January 19th, Mr. T. P. Roberts, the president, in the chair. The secretary's report showed a membership of 370. The following officers were elected for the ensuing year: President, Alfred E. Hunt; vice-presidents, one year, Phineas Barnes; two years, Charles Davis; directors, Robert Munroe, G. W. G. Ferris; secretary, R. N. Clark; treasurer, A. E. Frost.

PHILADELPHIA ELECTRIC CLUB.

SO many have responded to the call for names of those who would interest themselves in an electric club in Philadelphia and the encouragement given those who are soliciting personally, that we feel assured that the club will be a decided succcess. It is proposed that a notice be sent to each person whose name is received, to meet at some hotel to determine on future action.

THE PITTSBURGH ELECTRIC CLUB.

PRESIDENT Morris W. Mead, of the Pittsburgh Electric Club, has appointed the following committee for the government of the club:

House committee, N. H. Byam, chairman, H. Albright and F. H. Ketchum; entertainment committee, E. H. Heinrichs, chairman, W. McC. Ramsey and E. B. Thompson; membership committee, John Campbell, chairman, D. W. Dunn, and H. McL. Harding. At a recent meeting of the board of directors, Mr. Ernest H. Heinrichs, of the Westinghouse Electric and Manufacturing Co., was elected librarian and historian of the club.

Legal Notes.

ELECTRIC LIGHT PLANTS ARE FACTORIES EXEMPT FROM TAX.

AMONG the decisions handed down by the New York Court of Appeals, last week, was one favorable to the relator in the case of the People ex rel. the Brush Electric Illuminating Company, appellant, *vs.* Edward Wemple, Controller. This decision disposes of the interesting legal question whether or not a company which generates and distributes electricity is a manufacturing company within the meaning of the statutes of the State and therefore exempt from the payment of State taxes.

The Controller contended that as the company was not engaged in producing any material thing, it was not a manufacturing corporation within the meaning and intent of the law, and therefore was not exempt from the payment of such taxes. The company appealed from the Controller's order to the General Term, and that court sustained the decision of the Controller. From that decision the company appealed to the highest court, and that court has now by its decision sustained the contention of the company's attorneys.

TELEGRAPH BLANK DECISION—CANADIAN JUDGMENT THAT THE REGULATION PRINTED ON THE BLANKS IS NULL.

THE Court of Appeals has given its opinion of the contract which telegraph companies print on their blanks. The case was that of Lawrence *vs.* the Great Northwestern Company. While Mr. Lionel Lawrence was in New York, one of his employees sent him a dispatch saying: "Writing you to-night." The sentence was made to read: "Waiting you to-night." Consequently Mr. Lawrence made an unnecessary trip from New York to Montreal, and sued the telegraph company for $200 damages. The court in the first instance awarded $30, the actual cost of the trip from New York. The company appealed from this decision. The proof established the fact that the error was due to the negligence of the employees of the company, but the appellant set up the plea that the dispatches were sent under a contract which declared that it would not be liable for damages resulting from errors unless the dispatch was repeated, and then only to the amount of fifty times the price paid for the message. Such a contract the court declared to be contrary to public policy, and any contract by which a party sought to fix the punishment for his faults was illegal. The judgment was confirmed.

A TYPEWRITER SUIT OF INTEREST TO TELEGRAPHERS.

THE Remington Standard Typewriter Manufacturing Company and others have recently filed a bill of complaint in the U. S. Circuit Court, Southern District of New York, against Frank W. Bailey, who is selling the Franklin Typewriter, for infringement of the Crandall Patent which covers a vibrating platen used in combination with type bars carrying multiple type. H. D. Donnelly of this city appears for the complainants.

THE "K. W." VICTORY.

COMMISSIONER SIMONDS, on January 9, rendered a decision in the case of Dillon *vs.* Kimball and Wirt; Electric Cut-Out, in favor of the latter, it being proven that the testimony offered in behalf of Dillon would not stand the scrutiny to which it was subjected. The Commissioner considered that there were enough material faults in the case presented by Dillon to create a reasonable doubt as to its correctness from beginning to end, and the decision of the Examiners-in-Chief awarding absolute priority of invention to Kimball and Wirt was therefore affirmed.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JANUARY 19, 1892.

Alarms and Signals :—

Automatic Fire Alarm, G. S. Tilton, 467,212. Filed Nov. 2, 1891.
An alarm in which the circuit is held open by cords which run through the building and is closed by the burning asunder of such cords.

Electric Railway Signal, W. F. Z. Desant, 467,478. Filed Sept. 26, 1890.
An automatic system of electric block signals for railways.

Dynamos and Motors :—

Commutator, H. P. White, 467 215. Filed Feb. 13, 1891.
An arrangement by which the path of the current is changed during the revolution of the commutator.

Method of and Apparatas for Controlling Electric Motors and Generators, C. T. Hutchinson, 467,230. Filed Nov. 11, 1890.
A method of equalizing the work done by two or more motors.

Commutator for Dynamo-Electric Machines and Motors, E. Thomson, 467,318. Filed Jan. 31, 1891.
A disc commutator having sector shaped contact surfaces with a wedge shaped brush engaging such surfaces.

Regulator for Electric Generators, E. W. Rice, Jr., 467,358. Filed May 2, 1890.
Employs a controller for the electromotive force regulator depending upon the output of the machine, and set in action only at the point of maximum output.

Controlling Apparatus for Electric Motors, C. J. Van Depoele, 467,449. Filed Mar. 19, 1891,
A current regulating and reversing apparatus for vehicles.

Electromagnetic Reciprocating Pumping Engine, C. J. Van Depoele, 467,450. Filed Mar. 19, 1891.
A reciprocating pump electrically operated on the principle of the solenoid.

Reciprocating Electric Engine, C. J. Van Depoele, 467,451. Filed July 10, 1891.

Galvanic and Thermo-Electric Batteries :—

Battery-Zinc, C. B. Schoenmehl, 467,239. Filed Apr. 25, 1891.
A self-amalgamating zinc rod for batteries.

Electric Battery, C. B. Schoenmehl, 467,240. Filed Apr. 25, 1891.

Galvanic Battery, F. Gendron, 467,372. Filed May 14, 1891.
A battery in which the output is automatically regulated according to the work demanded.

Lamps and Appurtenances :—

Filament for Incandescent Electric Lamps, P. Hickley, 467,169. Filed Aug. 21, 1890.
A filament composed of a carbonized root of the rice plant.

Electric Arc Lamp, J. Riedel, 467,199. Filed May 28, 1891.
An arc lamp in which the arc is formed at a point of uniform height and regulated by means of movable carbon holders.

Incandescent Electric Lamp, C. H. Wilkins, 467,270, Filed June 19, 1890.
Employs a helical carbon wound about a conical reflector in the interior of the lamp.

Incandescent Electric Lamp, J. L. Curtiss, 467,276. Filed July 24, 1891.
Claim 1 follows:
An electric motor provided with a socket at one end adapted to receive an incandescent lamp, and electrodes at the other adapted to fit the lamp socket, and electrical conductors from said electrodes to said lamp.

Metal-Working :—

Process of Electric Metal-Working, H. Lemp and W. S. Moody, 467,233. Filed Apr. 23, 1891.
Provides means for correcting the tendency to localization of effects produced by two electric currents flowing at an angle through the same conducting medium.

Miscellaneous :—

Automatic Damper-Controller, F. E. Chatard, 467,153. Filed May 5, 1891.
A thermostatic device for automatically controlling the damper of a heater.

Electric Elevator, N. P. Otis and R. C. Smith, 467,192. Filed July 31, 1891.
Automatic controlling device for the motor operating an elevator.

Rubbing, Polishing and Sandpapering Machine, H. C. Strobel, 467,209. Filed July 10, 1891.
A sandpapering machine operated by an electric motor.

Liquid Rheostat, H. Lemp, 467,255. Filed March 22, 1889.

Automatic Cut-Off for Gas-Burners, J. E. Hogan, 467,287. Filed Apr. 20, 1891.
Provides a supplemental means of cutting off the flow of gas in case the key is accidentally left open.

Rheostat, C. Willms, 467,338. Filed Sept. 30, 1891.
A rheostat in which the collecting sectors are each of the same area as the cross section of the resistance material required at the plane of the sector.

Electrolytical Plant, O. Stalmann, 467,350. Filed June 8, 1891.
Claim 1 follows:
An electrode consisting of a plate of refined material and a plate of crude material with insulating material interposed between said plates and metallic connection between said plates.

Electric Lock, F. S. Holmes, 467,465. Filed Feb. 3, 1891.
A lock which may be electrically controlled at any given point of a station.

Electrolytical Process and Apparatus for Carrying Out Said Process, O. Stalmann, 467,484. Filed Oct. 1, 1890.
Similar to No. 467,350.

Railways and Appliances :—

Trolley for Electric Railways, E. R. Harding, 467,250. Filed Jan. 3, 1891.
A trolley provided with a spring which is automatically relieved of tension in the event of the trolley jumping from the conductor.

Electric Railway-Brake, E. Verstraete, 467,259. Filed Aug. 8, 1890.
An electric brake for steam railways.

Electromagnetic Brake, H. E. Walter, 467,243. Filed Apr. 3, 1891.
A car brake acting by magnetic action upon the rails of the track.

Electric Railway, C. J. Van Depoele, 467,448. Filed June 22, 1885.
An overhead trolley railway system.

Telephones and Apparatus:—

Holder for Telephone Receivers. R. Dent, 467,160. Filed Apr. 13, 1891.

THE ATHENS, GA., ROAD AND ITS YOUNG SUPERINTENDENT.

MR. J. T. VOSS, the general manager of the electric road of the Athens, Ga., Railway Co., has recently written the Detroit Electrical Works the following letter:

> In reply to yours of the 18th inst. regarding the Detroit Electrical Works. "Standard Electric Railway System," which you furnished the Equitable Engineering and Construction Co., of Philadelphia, for our line here, consisting of four 30 h. p. motors and one 80,000 watt dynamo, would say that we are well pleased with the equipments, and are satisfied that we are operating our motors 50 per cent. cheaper than any other system now in use.
>
> We have had very little trouble or expense with the bevel gear, in fact there is no trouble with it when the friction collars are kept well adjusted, which is very simply and easily done. And as to the dynamo, it has not caused us one minute's delay or one cent of expense. As to the whole equipment, we find it to be the simplest and easiest to keep in repair of any of the systems that I have ever inspected.
>
> I have a son 19 years old who has charge of all the cars and motors, and he keeps them in thorough repair; we never have lost as much as a day's service with any one motor, and all the experience he has ever had in electrical work was with your men while here setting up our machinery, while with other systems it is necessary to keep a high salaried expert to keep the machinery in order.
>
> I claim that we have got the best equipped road anywhere, to my knowledge. Our cars make less noise and run smoother than those of any other system that I have ever inspected. I have been in the street railway business for some 12 years, and last year, before we began to make any change in our line here, I made a tour of inspection of the different systems, going to Macon, Ga., from there to Atlanta, Chattanooga, Nashville, Louisville, Pittsburgh, New York, Jersey City, and also Washington, D. C. I became utterly disgusted with two motors to one car, and more especially when I went to the repair shops.
>
> The single motor geared direct to each axle, cannot be beat anywhere, and that is just what we have. We would be glad at any time to show any one our system here.

FRASER & CHALMERS TO USE ELECTRICITY IN THEIR SHOPS.

MESSRS. FRASER & CHALMERS, of Chicago, Ill., the great manufacturers of mining machinery and steam engines, have now shown their readiness to recognize the merits of electricity as a power transmitter and are about to fit up the foundry and boiler shop and the pattern shop in their Twelfth street works with an electric power plant. This plant will consist of two 80 kilowatt generators, one 25 h. p. motor, eight 10 h. p. and eight 5 h. p. motors, distributed throughout the various buildings. The generators and motors will be wound for a pressure of 250 volts. One advantage which is expected to be derived from the use of this potential is that while the electromotive force on the motor circuits will be kept down below any possible danger mark, yet by connecting two dynamos in series a pressure of 500 volts will be obtained, which will permit of testing the various electrical mining machines, the motors for which are usually wound for this higher potential.

Messrs. Fraser & Chalmers have had this plant under consideration for several months, and the competition among the various motor companies has been keen. The "C. & C.," Edison, Thomson-Houston, Eddy, Mather, Brush, Westinghouse and several others, eleven in all, submitted estimates. To the "C. & C." Electric Motor Company was awarded the prize in the shape of the contract for this installation.

It is understood that part of the plant is to be in running order within 60 days and the entire installation is to be completed within 90 days. The plant will be one of the largest as yet installed for general power purposes, and will afford an excellent demonstration of the advantages of electricity under conditions such as exist in Messrs. Fraser & Chalmers' works.

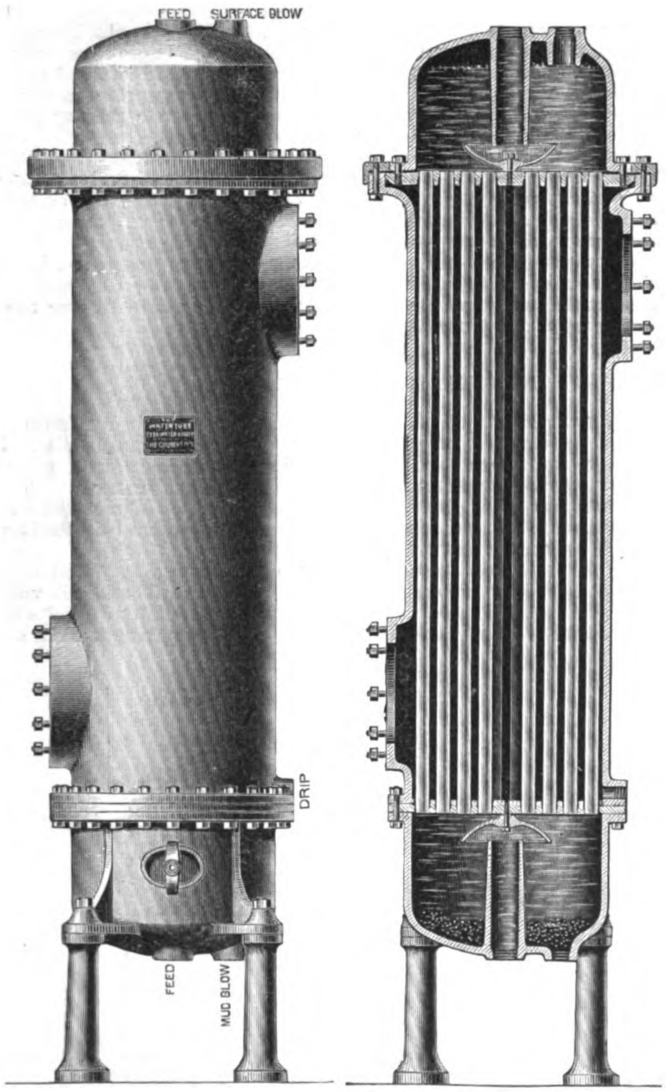
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Advertising is the magnet and trade the armature it draws.

THE GOUBERT "WATER-TUBE" FEED WATER HEATER.

The accompanying illustrations show the latest construction of the Goubert "water-tube" feed water heater. It is essentially composed of two cast iron water chambers connected together by a cluster of seamless drawn brass tubes, rigidly secured at their ends to the tube-plates by means of a roller tube expander in the same manner that boiler tubes are connected to the heads. These are the only parts of the heater under boiler pressure.



Figs. 1 and 2.—Goubert "Water Tube" Feed Water Heater.

The lower water chamber rests on legs on the floor while the upper water chamber is free to move vertically as the tubes expand or contract. The tubes are surrounded by a cast iron shell provided with inlet and outlet nozzles, to which are connected the exhaust pipes. This shell is bolted to the lower water chamber, but is free to expand independently of the tubes, its only connection at the top with the upper tube plate being made by means of a flexible corrugated copper expansion plate. This serves to close up the space between the upper tube-plate and the shell, and has no pressure to withstand but that of the exhaust steam, although it is protected and backed up in such a manner as to easily resist any pressure that may come upon it. At the extremes of temperature this corrugated copper expansion joint never has to spring more than three sixty-fourths of an inch either way, and is practically indestructible.

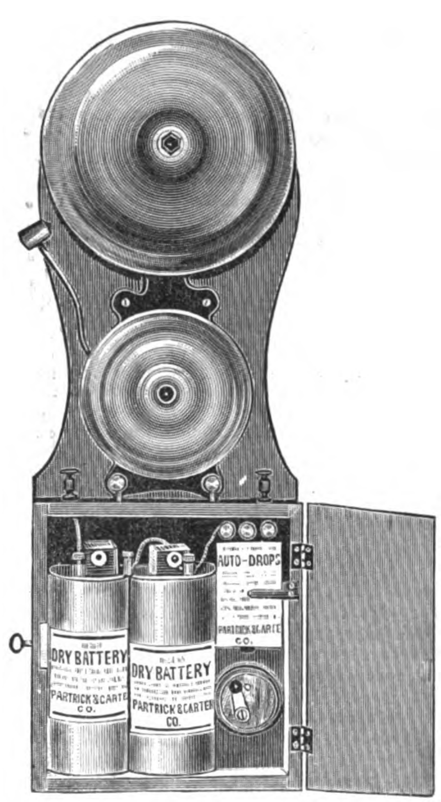
The water inlet and outlet pipes are made to project inside of the water-chambers, and opposite them are placed dish-shaped deflections to promote the separation of scum and sediment. Surface and mud blows, and also a hand-hole are provided for cleaning.

Among the advantages claimed for this heater are the following: The tubes are of brass, are free to expand; the pressure being from the inside they cannot collapse, neither can they leak at the ends, as the greater the pressure the tighter they become. By simply removing the head all the tubes can be easily cleaned. The area for the passage of steam between the tubes is from eight to sixteen times as large as that of the exhaust pipe, and consequently it cannot cause back pressure. The water, being divided up into small columns and in immediate contact with the heating surface, is quickly heated to the highest point.

This heater is manufactured solely by The Goubert Manufacturing Company, 32 Cortlandt street, New York.

PARTRICK & CARTER CO.'S HOTEL FIRE-ALARM SYSTEM.

The practice of connecting up a large number of electric gongs in series having been found unsatisfactory in a number of instances, on account of the mutual dependence of all parts of the system upon each other, Partrick & Carter Co., of 125 South Second street, Philadelphia, have devised the independent arrangement shown in the accompanying illustration. The apparatus consists of electric bells having gongs of from 6 to 10 inches mounted on a polished base, having a locked box attached for holding two cells of dry battery and an automatic drop. These drops are connected in series to their respective boxes in the halls and pushes in the office. This fire-alarm system has no connection whatever with the working of the annunciator, and does not in any way interfere with the working of the combination return call bells in the rooms. Upon pressing of the fire-alarm buttons, the drops in the various boxes in the series, or floor, operate and close the local circuit to their respective bells and batteries, each bell having its own battery and being entirely independent. The bells will continue to ring until reset. In each hall are placed small alarm boxes containing a push-button and provided with a very thin glass front, while a card of directions is placed in a conspicuous place, reading, "In case of fire break glass and push the button." The pushing of any one button on any floor. will cause all the bells on that floor to ring continuously until stopped by resetting the automatic drop in the bell box, and without the intervention of the office battery.


AUTO-DROPS
PARTRICK & CARTER CO.
DRY BATTERY
PARTRICK & CARTER CO.
DRY BATTERY
PARTRICK & CARTER CO.

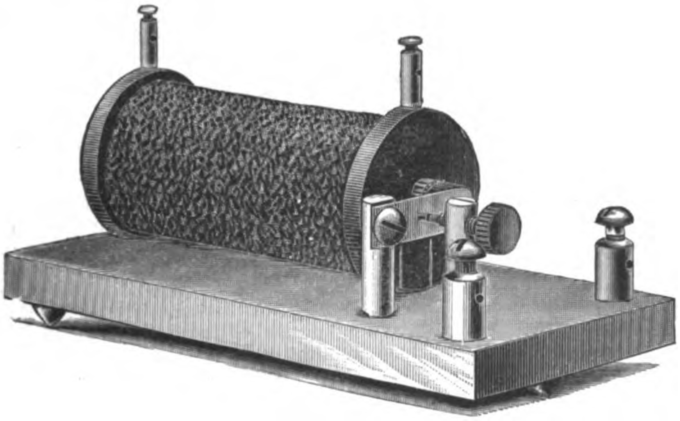
Partrick & Carter Co.'s New Hotel Fire Alarm.

The company guarantee a number of important advantages for their system.

THE TERROR INDUCTION COIL.

NEXT to the galvanic battery as a source of current there is scarcely a single piece of apparatus more valuable and instructive than the induction coil. While permitting of the demonstration of luminous, heat and other effects it brings clearly before the student the great principles involving the action of magneto induction as employed in nearly all modern dynamo electric machinery and especially in alternate current transformers of which it is a special type.

The "Terror" induction coil which is illustrated in the accompanying engraving is constructed on scientific principles, and of materials best suited to secure a high degree of efficiency. The primary coil has a resistance of 0.7 ohm, and the secondary, which consists of many thousand turns of No. 35 wire, has a resistance of about 1,100 ohms. The insulation throughout is carefully attended to, so that the coil will stand a high electric pressure without injury. The automatic break is substantially constructed, and the condenser is made of such size as is found by experiment to give the best results. The coil has nicely polished, hard rubber ends, and is mounted on a polished base of the same material.


THE TERROR INDUCTION COIL.

Among the numerous experiments which can be performed by means of this coil we may mention the following: Divergence of the spark towards a flame; sparking over finely divided metal; ignition of hydrogen gas and explosion of gunpowder, etc. To these must be added the beautiful luminous effects which can be obtained by the aid of vacuum or Geissler tubes, which constitute a never ceasing source of pleasure and instruction. The Blakeney Electric Co., of 431 Broadway, Brooklyn, N. Y., furnish for $5 a "Terror" coil giving a ¼ inch spark, 1 cell of electropoion battery, 1 six-inch Geissler tube, uranium glass, and a full set of accessories.

A NEW BUNNELL CATALOGUE.

J. H. BUNNELL & Co. have just issued a new edition of their catalogue, for 1892, No. 12. It is a fine trade publication of no fewer than 224 pages, and the contents are so numerous that the heads under which they fall make up nearly 700 titles in the index. This fact alone speaks volumes for the scope of the electrical industry as represented by this house, but it must be mentioned that even then the catalogue is not as complete as the firm would like it to be, as many of their lines of electric railway, electric light and other supplies have been omitted. The omissions will be supplied in a special supplement at some future time, but meanwhile the catalogue serves most admirably for any and all of the different branches of supply trade. The articles shown and enumerated range from the famous Bunnell key, which literally swept the country when it made its appearance, down to the Ries incandescent lamp socket, the latest novelty of importance in the lighting field. Altogether the catalogue is a very useful—in fact, indispensable—book of reference for all who have to purchase electrical goods.

PERFORMANCE OF THE JOHNSON SWITCH.

ONE of the most interesting articles in the current issue of THE ELECTRICAL ENGINEER is that by Mr. E. H. Johnson, president of the Interior Conduit & Insulation Co., on his switch for electric light and power work. Mr. Johnson, with wonted force and clearness, describes the principles and features of the device. It may be added here that the switch has been under some very severe tests, with highly satisfactory results. One of these took place last week in the Edison Building, Broad street, where the offices of the Interior Co. are located. The building is connected with the down town Edison station, and has a new plant of its own, and the test was made on the street current. The switch was loaded with 170 amperes at 125 volts, and took the swift changes serenely. The rapid throwing on and off of the load was noticed at the station, which had not been apprised, and thinking it might perhaps be a short circuit on their underground system they immediately raised the voltage to 140 to burn it out. But the switch went through the ordeal very gracefully, and being 'indestructible" is still there for a long career of usefulness. The fact that a 50 or 100 ampere switch can thus be got down to so minute a size shows more than anything else the immense advance that is being made in this important department of station and building appliances.

IMPORTANT SHORT RAILWAY CONTRACTS.

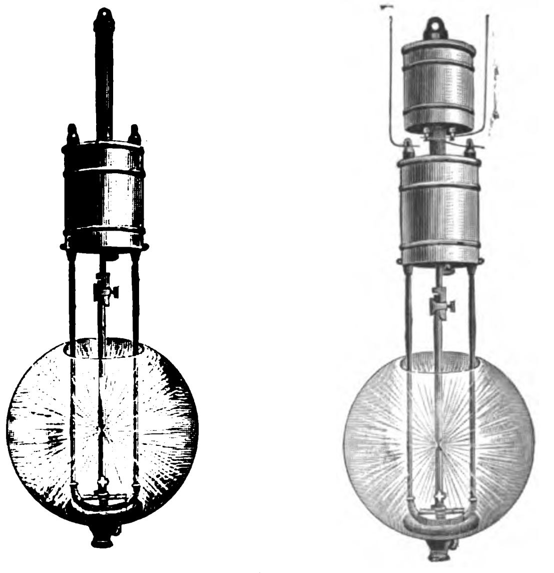
THE Short Electric Railway Company have been fortunate in securing from the Minneapolis Street Railway Co. an order for their entire spring requirements. It will be remembered that this road is one of the largest in the country, operating about an equal number of Thomson-Houston and Sprague equipments. In the extensions to be made this spring, the Minneapolis Company found it necessary to purchase 120 motors, and made a careful investigation of the latest types of motors as made by the leading electrical companies, finally selecting the Short gearless motor as embodying all the best features for modern electric railway practice. The motors are to be in operation by April.

The Consolidated Street Railway Co., of Grand Rapids, Mich., have just placed an order with the Short Electric Railway Company for twenty 40 h. p. gearless equipments to be used on their lines, which are being changed over to electricity. This contract was made after very careful personal investigation of all the leading systems by the general manager of the company, Mr. J. R. Chapman, and is significant as showing in what direction engineers and practical street railway men are looking for the most improved railway practice.

THE MOSHER ARC LAMP.

THE accompanying illustrations show the Mosher arc lamp designed for direct or alternating current incandescent circuits. It is the result of over two years' practical test and use, and, as now constructed, possesses many novel and economic features. In its construction all clockwork is dispensed with. It is provided with a switch and cut-out so that when the carbons burn out, the lamp will be automatically cut out of circuit.

These lamps can be used singly on any voltage of from 50 to 125, or can be run in series of 2, on a circuit of 100 and 125 volts, and 2, 3 or 4, on a 220 volt circuit, or in series of 5 to 10 on a 500 volt circuit. They can be adjusted so as to pass from 8 to 10 amperes each, and to yield from 500 to 2,500 or more candle power. They are made in two sizes; one 42 inches in length, which receives a pair of ordinary length carbons; the other is 52 inches long and will receive 24½ inches of carbon and burn all night. The carbon holders are made to receive carbons varying in sizes from 7/16 to 5/8, and the length of the arc is easily adjusted by means of a regulating screw at the lower end of the spring.


FIGS. 1 AND 2.—MOSHER ARC LAMPS.

The resistance, composed of fine braided wire, is enclosed in the case at the top of the lamp, or may be located at any convenient place away from the lamp, and is also adjustable.

The lamp is so constructed that a weather hood is unnecessary.

NEW SOMOFF LAMPS.

Mr. J. L. Somoff, of No. 1 Ann street, this city, is out with the second part of his lamp catalogue, which contains a number of styles of novel incandescent lamps of low voltage. The demand for such lamps, he says, is steadily growing, and the after-Christmas trade is as brisk as it was in December.

In the accompanying illustrations, Fig. 1 is one of the "Prism" lamps. Mounted upon a chandelier and lighted, they produce the most beautiful display of rainbow colors, the effect being incomparably superior to that of the prisms suspended from a gas chandelier.

A "Torch" lamp, Fig. 2, was designed by Mr. Somoff for purposes of theatrical display, etc. It has four lenses fused on the outside, all the surface around them being frosted. The effect of this combination of a true spheroidal form of the globe with frosting and lenses is to project the light in the form of four condensed beams. During December 450 of these lamps were used upon European stages in the production of the opera "Robert le Diable." They were mounted on torches, containing small storage batteries. Little vanes at the bases of the lamps revolved the lamps with the least motion of the air, the beams of light striking in every direction.

Fig. 3 shows a miniature wall bracket, one-third actual size. Until lately, there have been no brackets on the market suitable for miniature lamps, and it has been found difficult to place them, especially when intended for artistic display, in a way that insures the best effect. This cheap bracket is simple, neat and effective.

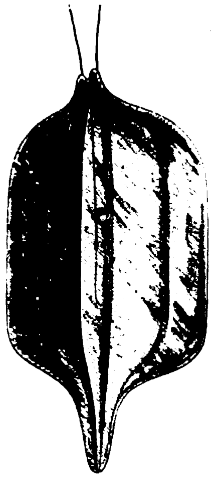


Fig. 1.

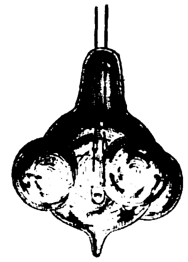


Fig. 2.

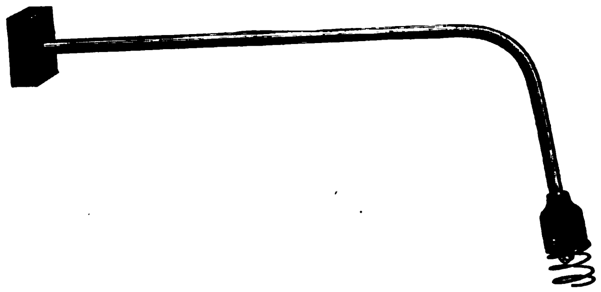


Fig. 3.

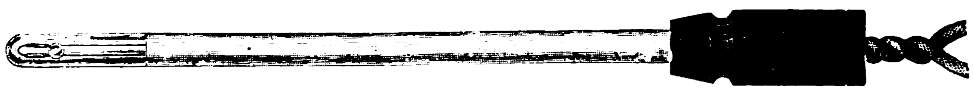


Fig. 4.

Somoff Incandescent Lamps and Socket.

Fig. 4 is an antiseptic surgical lamp which a year ago came into very extensive use by physicians. It is made wholly of glass; the part surrounding the filament of crystal, and the rest, serving as handle, of opaque, milk-white glass. Any uncleanliness can thus easily be seen and readily removed.

Mr. Somoff has also a number of novel and artistic forms of lamps for a variety of purposes.

LONG-DISTANCE ELECTRIC POWER TRANSMISSION—A CORRECTION.

In the article on "Long Distance Transmission of Power by Electricity" by Mr. Francis R. Hart, which appeared in our issue of January 13th, a slight error, due to the engraver, was made in the chart accompanying the paper, on page 43. The percentages marked on the upper left-hand side of this diagram should be made to read in the reverse order from that in which they appear; that is to say, as 20 per cent., 10 per cent. and 5 per cent., beginning from the left.

PELTON WATER WHEELS.

The Pelton Water Wheel Co. report the following recent sales of their water wheels and motors: Four motors to the London Hydraulic Power Co., to operate under 750 lbs, pressure; two motors to the Candelaria Mining Co., Mexico, to run electric generators, under 1100 ft. head, for a Thomson-Van Depoele drilling plant; one 4 ft. wheel and one motor, to run machinery at Hackberry Mines, Arizona, under 1200 ft. head; four 3½ ft. double nozzle wheels and one 6 ft. triple nozzle wheel to run under 24 ft. head, for Limon Electric Plant, Salvador, C. A.; one 4 ft. wheel to Georgia Marble Co.; three 8 ft. wheels for Anaconda Smelting Co.; two motors for Backus & Johnson, Lima, Peru; one 6 ft. wheel for Gold King Electric Plant, Telluride, Colorado; one 8 ft. wheel, for running electric transmission plant, Consolidated Mining Co., Belmont, Telluride, Colo.; two motors to De Beers Mining Co., Transvaal, S. Africa; one 8 foot wheel for running a silver mill, at Lewis, Nevada; one 5 ft. wheel, to Porte Cortez, Honduras; four 5½ ft. double nozzle wheels, for an electric light station, at Santa Anna, San Salvador, C. A., to operate under 60 ft. head; one 6 ft tripple nozzle wheel, for Santa Anna Water Works, San Salvador, C. A.; one motor and one 6 ft. special wheel to Nicaragua, C. A.; one motor to Ricaurate, Salvador, C. A.; one motor for Coffee Plantation, Esperanza, Guatemala; one motor to Callao, Peru; one 6½ ft. special wheel, and one 3¼ ft. special wheel for St. John Del Rey Mining Co., Brazil; two 5½ ft. wheels for running an electric light plant in Japan; one 11 ft. wheel, one 8 ft. wheel, one 1½ ft. wheel, and six 3½ ft. wheels to the Columbia River Paper Mills, La Camas, Washington.

WITH MERCHANT & CO.'S BROWNIES.

Some months ago the metal firm of Merchant & Co., of Philadelphia, issued a most dainty illustrated brochure in which, with the aid of a clever artist, they depicted the Brownies using their various productions in wire, solders, rolled metal, roofing, ventilators, etc. They have now followed that up by a very pretty New Year companion piece, in which they associate their products and the Brownies with the Chicago World's Fair. It is a skillful handling of the subject and some of the pictures are at once humorous and beautiful. At the outset we see the Brownies of all nations heading for the Fair, and all their adventures, misadventures and amusements are mixed up in a Gilbertian manner with cornices, roofing, babbitt, fuse wires and pipe, until one awakes to the enormous possibilities of what we may term industrial comic opera. One is loathe to part with the charming ballerina whose acquaintance is made in the opening pages, she is so altogether gay and graceful, but we live in hopes of meeting her again through the kindly offices of Merchant & Co., to whom and to whose artist we beg to tender the assurance of our most distinguished admiration.

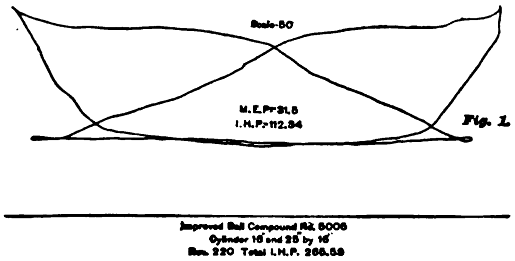
QUICK WORK ON LAVA INSULATORS.

An order was received at Wednesday noon, Jan. 20, by the D. M. Steward Mfg. Co., Chattanooga, Tenn., from the Standard Electric Co., of Chicago, for 5,000 of their lava insulators. By Wednesday night the entire lot was turned out. The pieces were hardened on Thursday, and the whole order was shipped on Friday morning. There is very often a sudden need for insulators such as small bushings, washers, etc., and manufacturers of lamps and other apparatus will certainly find it worth their while to avail themselves of such facilities.

Prof H. T. Bovey, of McGill University, Montreal, has been in New York during January, with Mrs. Bovey, a guest of Prof. Egleston, of Columbia College, at the latter's residence in Washington Square. Many New York electricians who met him during the Electric Light Convention, have been glad of an opportunity thus to see him again. While in this city Prof. Bovey was quite busy on work connected with the new buildings and equipment which will go far to make McGill one of the very first seats of learning on this continent.

IMPROVEMENT IN BALL COMPOUND ENGINES.*

THE accompanying diagrams were taken from a 250 h. p. cross-compound engine just installed in the station of the Edison Electric Illuminating Company of Paterson, N. J. The engine was designed and built by the Ball & Wood Co., at their Elizabethport shops, and embodies some new features in the arrangement of low pressure valves. The steam chest of this cylinder is placed directly underneath, and contains two valves, both of which are double ported, giving large and direct ports with very small clearance. The diagrams speak for themselves as to the efficiency of this arrangement. The dimensions of cylinders are as follows: high pressure 16 in. dia. x 16 in. stroke; low pressure, 25 in. dia. x 16 in. stroke; speed, 220 revolutions.



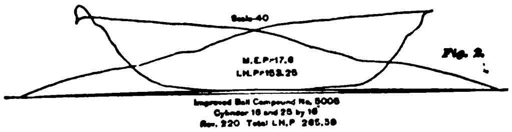
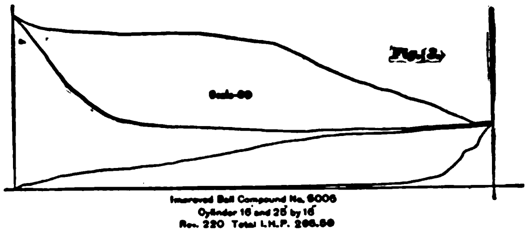
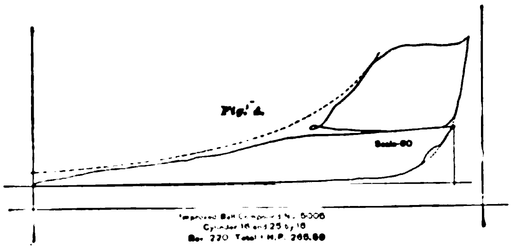


Fig. 1 is a reproduction of cards from high pressure cylinder, and Fig. 2 simultaneous cards from low pressure cylinder. Fig. 3 represents a combination of the cards, showing their relation to each other and the measure of loss between the cylinders up to point of cut-off. In Fig. 4 the cards from both cylinders are referred to the low pressure cylinder in the usual manner, and show the efficiency of the system. The theoretic expansion and compression curves are shown in dotted lines. No tests of economy have yet been made, but the very small losses between the cylinders and in back pressure promise an excellent showing.





This engine being the first of its kind, and not having been tested at the works for lack of time, considerable interest was manifested in its start, and quite a number of people assembled to witness its first move.

THE AMERICAN ELECTRICAL WORKS, of Providence, and the Eugene F. Phillips Electrical Works, of Montreal, have just issued a very pretty calendar for 1892. It has an ornamental design of the world enveloped in lightning clouds, with a pole line reaching out into the distant background. At the bottom is a large-number pad.

THE SOUTHERN ELECTRIC COMPANY.

THE Southern Electric Company of Baltimore, Md., is nearly ready to place on the market a number of specialties which bid fair to make great changes in the method of wiring buildings for incandescent lighting and also in the apparatus for handling them. These devices have been carefully worked out by the electrician of the company, Mr. Painter, under the direction of Mr. J. F. Morrison, the president of the company, and when the details are made known as to how 10 chandeliers of 14 lights can be controlled from a little plate of less than one foot square (which is only a small part of what has been accomplished) the market may well consider itself treated to something entirely new.

The Southern Electric Company has been somewhat delayed in getting out these new specialties through being pushed with contract work. Besides these features the company is doing an enormous business in wire, of which it claims to have sold during the past few months more than any other one electrical supply house in the United States. This is a pretty big claim, but the Southern is ready to back it by showing its hand.

NEW ENGLAND NOTES.

TELEPHONES AND THE NEW RECIPROCITY TREATIES.—Owing to the favorable nature of the new trade reciprocity treaties, the outlook for the introduction of electrical goods in the West Indian Islands, and various countries of the Spanish Main is excellent. Mr. James H. Howard, general manager of the Tropical American Telephone Co. has, with his usual vigilance, prepared for the situation and now has agencies and supply depots established in Barbadoes, Jamaica, Cuba, Porto Rico, &c. He is also making arrangements, it is said, to represent the Hunning long distance transmitter, Bell & Blake sets and Gower-Bell sets, of the Consolidated Telephone Maintenance & Construction Co. of London, for the tropical field. Mr. Howard in a recent conversation said that "he had been allowed three more patents on telephone transmitters and magneto call bells, which will enable the company in March, 1893, to offer the public a complete set of private line telephone instruments, the transmitters of which will be entirely different from present forms and will be free from any interference with Blake, Berliner or Hunning." He says that the expired claims on Edison's, Blake's and other telephones open the field in a variety of ways, especially Edison's English patent 2909 of 1877 which expired July 30, 1891. Mr. Howard furnishes the following suggestive little list, from which he seems to derive considerable comfort: Bell's original patent of 1876 expires March 7, 1893; Blake's English patent 229 of 1879 expires Jan. 20, 1893; Hunning's 3647 of 1878 expires Sept. 16, 1892 and Crossley's, 412 of 1879, expires Feby. 1, 1893.

THE EDDY ELECTRIC MANUFACTURING COMPANY, of Windsor, Conn., have such a great demand for their automatic motors and other electrical apparatus, in the vicinity of Boston, that they have decided to open a branch office in that city. They have accordingly secured convenient quarters at 39 Oliver street, and have appointed Mr. Edwin R. Gilbert as manager, who will be pleased to furnish all information regarding dynamos and motors. Mr. Gilbert has had an excellent experience both in the factory and in the selling department, and celebrated his appointment to the Boston office by selling a motor within fifteen minutes after his arrival in the city. Doubtless Eddy motors will become more popular than ever in the East, and Mr. Gilbert gives every promise of being a keen competitor for business.

THE DOW ADJUSTABLE LIGHT COMPANY, of 309 Washington street, Boston, are kept busy supplying the demand for their new adjustable incandescent light balls. This is a device by which lamps hung on cord can be raised or lowered to any desired height by coiling up the cord inside of a hollow ball. The device works perfectly, and there are no complicated parts to get out of order. The ball is made of metal, and contains a spring cylinder upon which runs the cord, allowing the light to be raised or lowered to the desired position, being operated in the same way as a curtain fixture.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., have recently contracted with the Val. Blatz Brewing Company, of Milwaukee, Wis., to equip their new works with electrical power apparatus consisting of about 350 h. p. of generators and 400 h. p. of motors, the generators being 175 h. p. each, and the motors ranging in size from 10 to 50 h. p. This is probably the largest isolated electric power plant ever contracted for, and Mr. F. A. Baux, the Chicago manager of the Mather Company, has the honor of sharing the triumph with Mr. Julius Andrae of Milwaukee.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

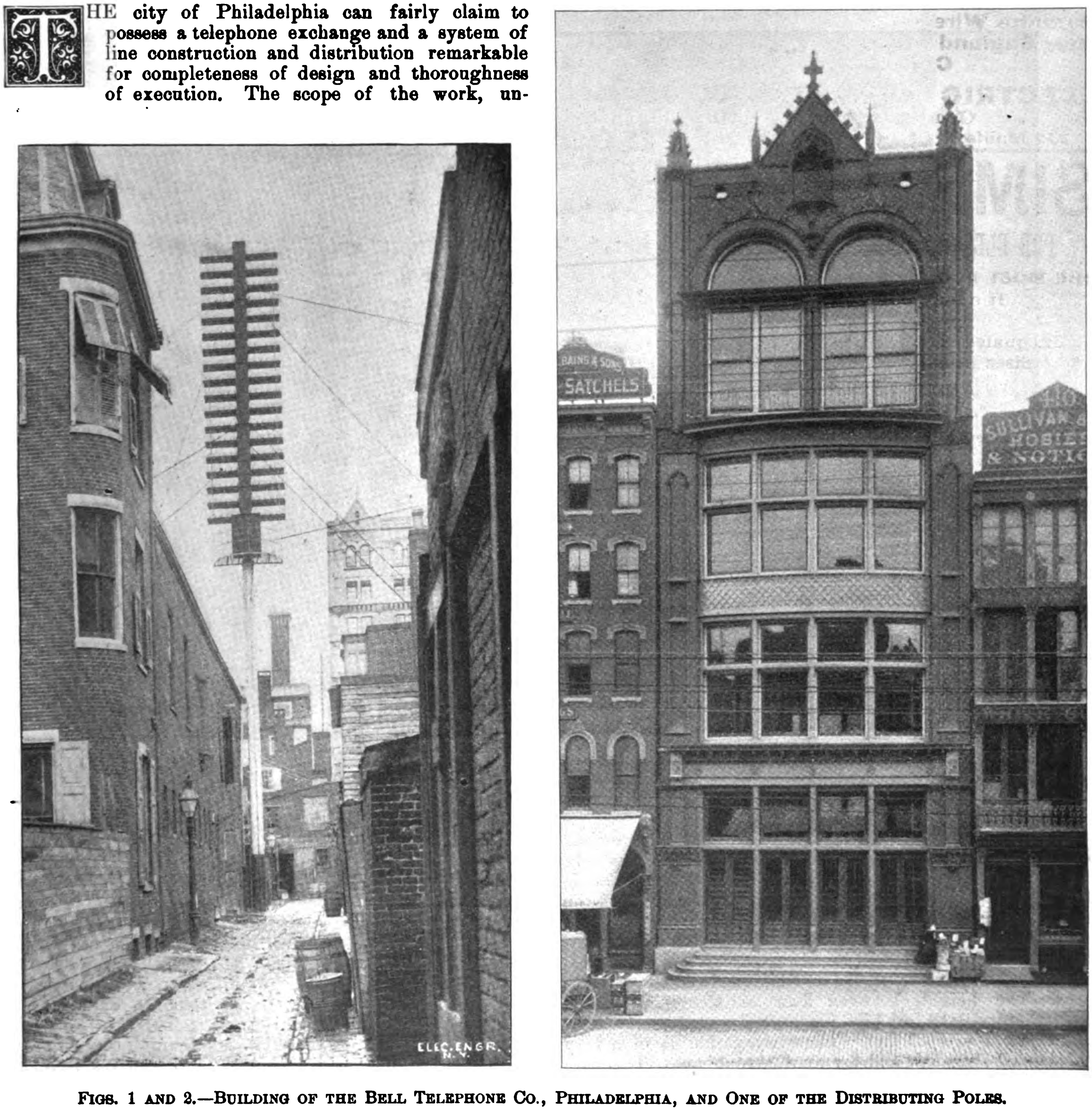
Vol. XIII. FEBRUARY 10, 1892. No. 197.

THE BELL TELEPHONE CO., OF PHILADELPHIA—ITS NEW PLANT.

BY

Geo. M. Phelps

THE city of Philadelphia can fairly claim to possess a telephone exchange and a system of line construction and distribution remarkable for completeness of design and thoroughness of execution. The scope of the work, undertaken, some four years ago by the telephone company, included not only a central station building—to be wholly occupied by the telephone service—an entire new outfit of station apparatus and a system of underground conductors; but included also an amplification of the whole plan sufficient to provide for the growth of twenty years to come. No less a sum than $750,000 has been expended in the new work. The directors and officers of the company went about their plans and work in a large-minded way, and upon specifications and estimates thoroughgoing, and ample enough to secure a plant that should not



Figs. 1 and 2.—Building of the Bell Telephone Co., Philadelphia, and One of the Distributing Poles.

only be permanent but should embrace such devices and methods as had proved their value in the past as well as newer features adapted to promote convenience, safety and efficiency in the operations of the service.

THE NEW BUILDING.

Some readers will recall the former exchange and offices in the Wood Building, at Fourth and Chestnut streets, with roof fixtures and the usual mass of overhead wires, like cobwebs across the sky. At 406 Market street, extending through to Merchant street in the rear, and but a short distance away, may now be seen the new building, with no external indication of the entrance of any wires. It is a handsome structure, of iron, brick and terra-cotta, and has been carefully planned for commodiousness and the admission of ample light. The view given herewith, Fig. 1, is of the Market street facade, which is precisely similar to that on Merchant street. The ground space is 117 feet by 35 feet and 6 inches. The total height of the building is upwards of 80 feet. Unusually high ceilings are therefore afforded for the four floors above ground. In our illustration it will be observed how far the telephone building towers above its four and five-story neighbors. The height, between floor and ceiling, of the ground story is 18 feet; of the second and third 16 feet, and of the fourth 23 feet. The construction is of a very substantial character and fireproof throughout. The cost of the lot and building, including boilers and steam-heating plant, ready for the introduction of cables and electrical apparatus was $175,000. The basement is occupied for the entrance of cables from the street conduits, by the steam plant and a workshop. On the first floor, about 3 feet above the ground level, are located the connecting board and protectors, offices for the superintendent, chief inspector, chief of construction, and chief of reconstruction, the supply department, and a public pay station, with long-distance service. The executive offices are assigned to the second floor, together with accommodations for the clerical and accounting departments. Here are found the rooms of the general manager, treasurer and cashier. Part of the third floor is given to the technical department—electricians and draughtsmen. The remaining portion will include the meeting-room of the Board of Directors of the Bell Telephone Company of Philadelphia, and the executive and clerical offices of the Delaware and Atlantic Telegraph and Telephone Company. The top floor is devoted wholly to the operating department.

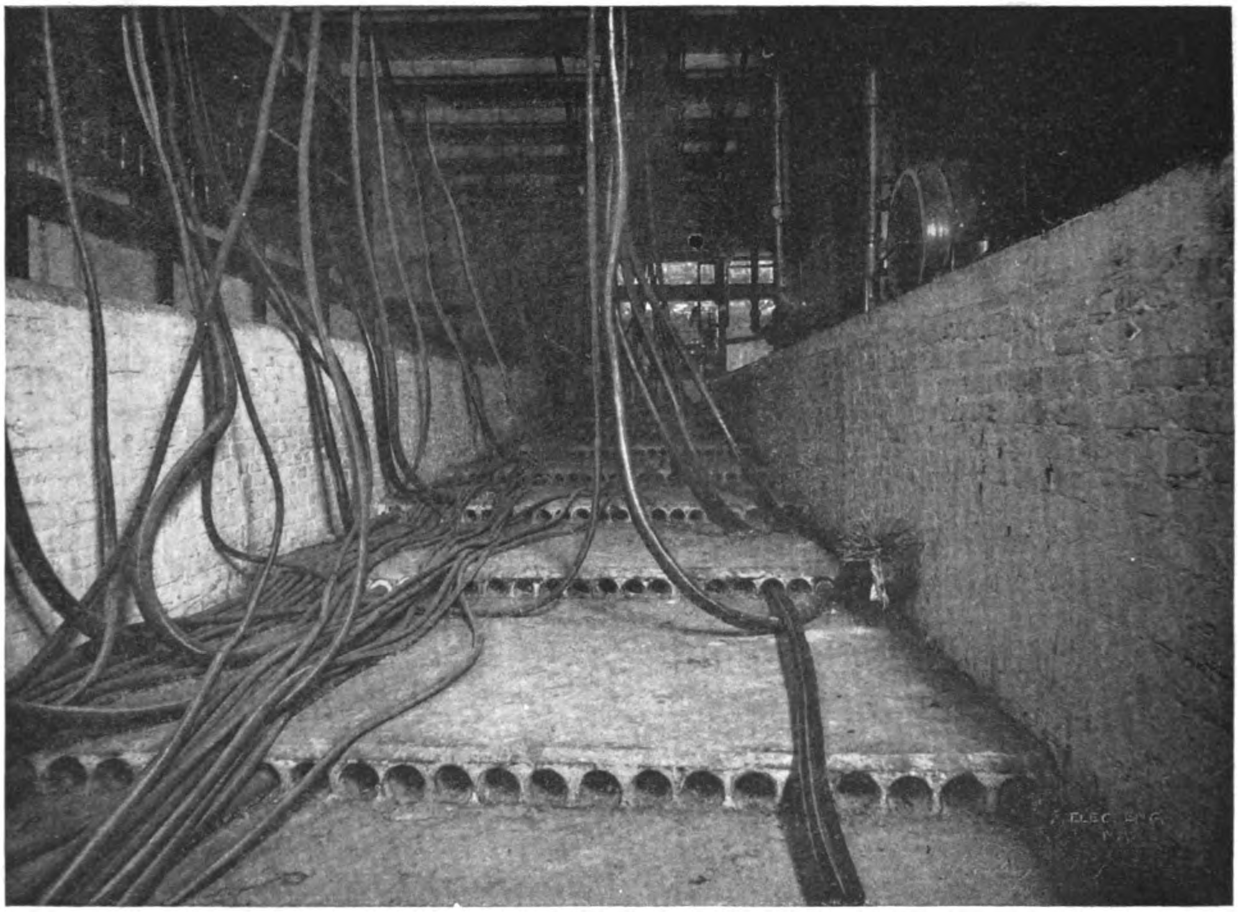


FIG. 3.—CABLE VAULT.

UNDERGROUND CABLES.

All of the 3,500 subscribers' lines now in use are in underground cables to a considerable distance from the Exchange, some of the cables extending two miles. The conduits and cables now cover practically all points within the city proper, that is, from Vine to South streets and from the Delaware to the Schuylkill rivers; beyond which district pole lines continue circuits to more distant subscribers. The cables are, uniformly, 2 inches in diameter and contain each 110 No. 18 (B. & S. gauge) copper wires twisted in pairs and laid up spirally. The wires have an insulating covering of dry paper. The covering pipe is of lead, with three per cent. of tin, and weighs 3.5 pounds per foot. These cables have all been made by the Electric Cable Construction and Maintenance Co., of Philadelphia.

Their adoption for the entire system has been the result of prolonged and satisfactory trial by the Telephone Company. Their low inductive capacity is noteworthy, namely: .07 to .08 microfarads per mile, as shown by many and oft-repeated tests. They are drawn into ducts 2½ inches in diameter. The ducts are first filled with a plastic composition impervious to water and gases. Through devices employed in drawing in the cable the plastic material is partially drawn out of the duct, the portion remaining thus forming a complete envelope for the cable and entirely filling the space between the lead pipe and the duct. Iron, indurated fibre and creosoted wood have each been used as material for the ducts; the latter, however, has been found most satisfactory and is chiefly employed in all the more recent work. The ducts are made of square timber—preferably of white pine—in lengths of eight feet, and are thoroughly "creosoted," 12 pounds of dead oil of coal-tar being absorbed to the cubic foot. Manholes are located at street intersections, usually about 500 feet apart—in some instances much closer—for convenience in drawing in cables, making splices, etc., and vary greatly in size, according to circumstances. The largest, on Market street, where the number of ducts ranges from 90 to 130, are 10 feet square and from 8 to 10 feet deep, affording space equal to a moderate-sized room. The smallest of these manholes are 3 by 4 feet and from 4 to 6 feet deep, located in small streets or alleys, near the bases of the distributing poles.

The street plan of Philadelphia—almost entirely rectangular and including a series of narrow streets, lanes or alleys, running midway between the principal streets east and west—affords special facility for the distributing system adopted. From a manhole adjacent to a distributing point, a smaller cable, having smaller conductors but of precisely the same type and construction as the main cable to which it is jointed, is led a short distance through a conduit to a distributing pole set at the curb and about midway of a street block in one of the intermediate alleys. By overhead wires from the pole, convenient access is had to the roofs or windows of all buildings in the block. One of these poles is shown in Fig. 2, page 129. They are about 90 feet high. The cable is run up the pole to the platform and terminal box, as shown in the illustration, protected for some twelve feet above the ground by an iron pipe. The particular pole shown provides for twelve wires from each cross-arm—216 in all, or for 108 metallic circuits.

As before stated the conduit system occupies the territory embraced in the old city proper, between the Delaware and Schuylkill rivers and Vine and South streets, in which portion of the city are located about five-sixths of all the subscribers to the Exchange. The plan of the system somewhat resembles in outline a tree, the trunk being on Market street, the principal limbs on each alternate street north and south, and the branches leading from there east and west, through small streets, to reach the poles located near the centres of the blocks.

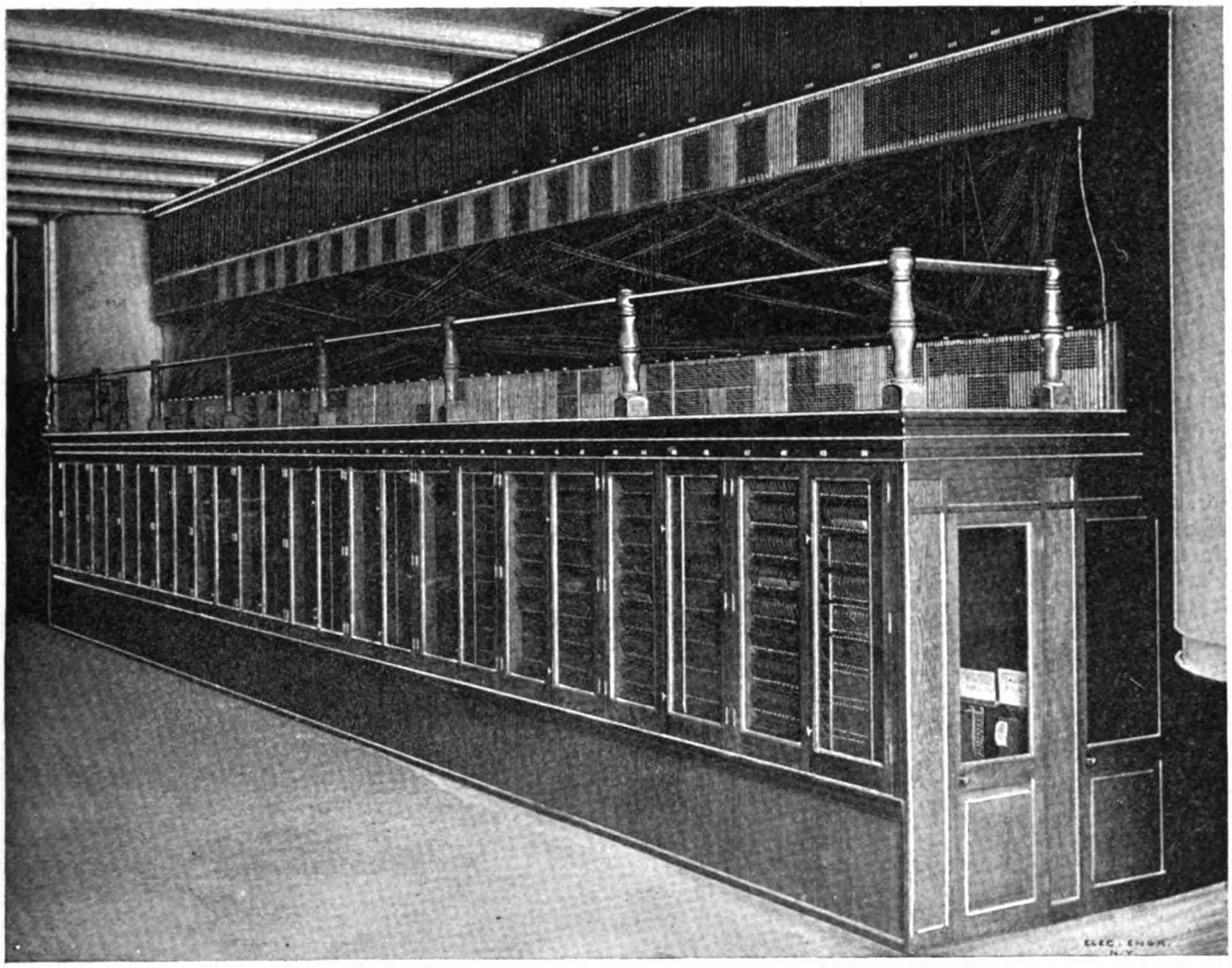


FIG. 4.—CONNECTING AND PROTECTOR BOARD.

The extent of the underground work accomplished up to January 13, 1892, is shown by the following table:

	Feet.	Miles.
Conduit laid	91,148	17.26
Duct laid	1,130,864	214.18
Cable drawn in	113,932	21.57
Single conductor	12,410,171	2,350.41
" " in use	7,034,020	1,332.18

There are 199 large manholes and 124 smaller ones. The line construction has cost $492,000, something more than half of which sum was for the cables alone.

The cables are all brought into the building through a vault under the sidewalk on Market street whence they are led through conduits into a trench-like pit running lengthwise of the basement and immediately under the position of the connecting board on the floor above. The illustration herewith Fig. 3, page 130, shows this arrangement so clearly that no further description is required.

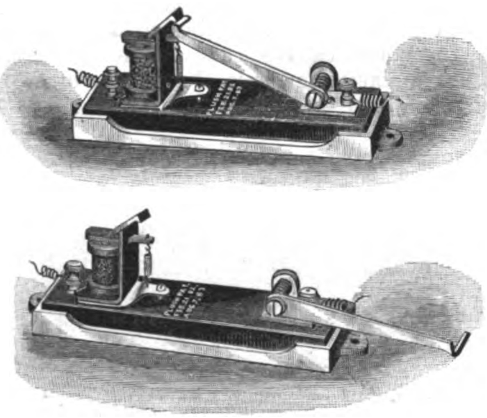


FIG. 5.—PLUSH ELECTRIC PROTECTOR, CLOSED AND OPEN.

INTERIOR OF THE EXCHANGE.

The principal apparatus on the first floor is the protector and connecting board, a view of which is given in Fig. 4, showing the long cabinet with glass doors, containing the protectors; and above it the arrangements for connecting, and for changing connections, between the protectors and the conductors leading to the switchboard on the top floor. A Plush electric protector is here interposed in the circuit of every line running into the Exchange. They are exposed to view and readily accessible to attendants. These very efficient protectors against heavy currents accidentally entering will be recognized as familiar acquaintances by many readers who have seen them in use. The latest form in which they are now made by the Electric Protection Co., of Philadelphia, is seen in Fig. 5, closed and open. When actuated by an electric light or other too powerful current they make an absolute break of three inches in the circuit. The protector cabinet (Fig. 4) is arranged to receive no less than 20,000 of these protectors; nearly 4,000 being already in position.

From the bars of the connecting board, near the ceiling of the first floor, connections are run to the fourth floor in lead-covered cables through iron pipes concealed from view between a wainscotting and the wall of the building. Between the ceiling of the third story and the floor of the fourth a space of several feet, sufficient to permit the entrance of workmen, is provided, through which the cables are carried across the building, terminating immediately beneath the switchboard. Fig. 6 exhibits the operating room, with the switchboard—or table—on the right, looking toward Market street, and the circuit board on the left; an enlarged view of the latter being shown in Fig. 7. with Manager U. H. Balsley at his post. The switchboard is of a new and improved type, combining features never successfully attempted before—whereby 10,000 subscribers with metallic circuits can be brought within easy reach of each operator.

The system is the same as that employed in the old exchange, adopted some 10 years ago, having two wires to each subscriber's station; one for calling on and calling off and the other for conversation. The apparatus, while improved in the main, embraces the general features of the system familiar to most of our readers as the "Law" system. That system was very successfully employed in the telephone exchange operated by the Law Telephone Co. in New York, until a few years ago, and is used now in many other exchanges, particularly in those of the Southern Bell Telephone Co., which adopted it twelve years ago. When the telephone company determined to undertake the extensive building and construction described in this article, a careful consideration led them to refit with the same system. Much weight was given to the advantage that a subscriber, having both his independent line and constant access to a calling circuit, cannot be wholly shut off from "Central" by failure of an operator to disconnect.

The switchboard in the Philadelphia Exchange is remarkable for its compactness. Its length is 85 feet, and in that space it will serve until the number of subscribers lines reaches 6,000; each of its thirty sections contains 6,000 sockets for subscribers' connections. The sockets are constructed for metallic circuits, double cords and plugs being provided for the subscribers' lines. A similar board or table of 20 sections, when added, will provide for an increase to ten thousand lines. The subscribers' lines are not yet actually worked on metallic circuits, but the switchboard is connected up and used precisely as if they were: that is to say, the return connections from the double cords of the switchboard are all bunched and connected to a common ground. Complete metallic circuits, through the twisted pairs of conductors in the underground cables, can be established at any time for any number of subscribers without changing or interfering with the switchboard. The compactness of the arrangement of the double contact sockets is a very striking feature; each of the half-sections of the cable containing 3,000 of them, arranged in blocks of 100 each—each block occupying a space on the table of but 3⅛ by 2⅝ inches. The brass strips in each socket are firmly imbedded in hard rubber, vulcanized after the insertion of the strips. The operation of vulcanizing the rubber sections with the metallic strips in position is regarded as a feat of some difficulty, and was said to be impracticable by rubber manufacturers.

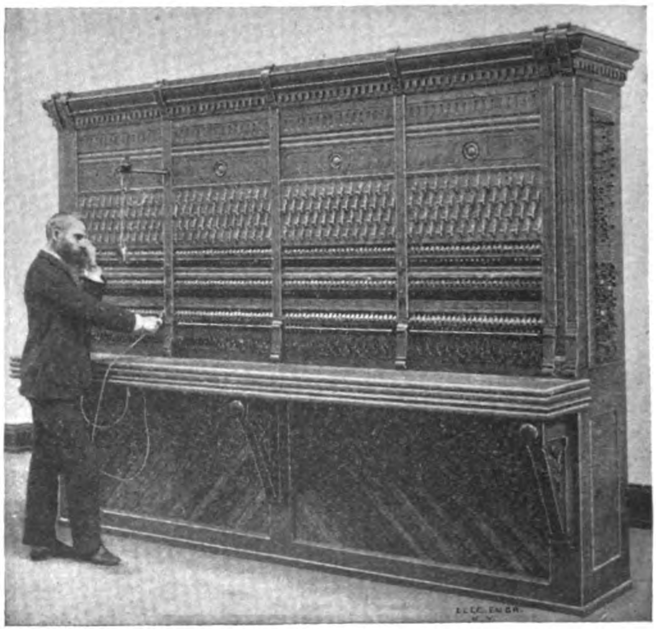


FIG. 7.—CIRCUIT BOARD.

The circuit board, Fig. 7, is fitted with testing keys, for trying the continuity and electrical condition of circuits, spring jacks, with cords and double plugs for looping calling circuits, and with strap and pin switches for connecting the several sections of the operating table to calling circuits as desired. On one end, at the right in the figure, is a strap and pin switch for battery or dynamo connections for the call-bells.

The manufacture and the setting up of the switchboard, protector board and other electrical apparatus have involved an expenditure of not less than $75,000.

The switchboard and other electrical apparatus were practically completed some months ago, when the operating department was transferred to the new building. The executive offices have now been removed from the old quarters at Fourth and Chestnut streets, the entire service and administration being established under one roof again.

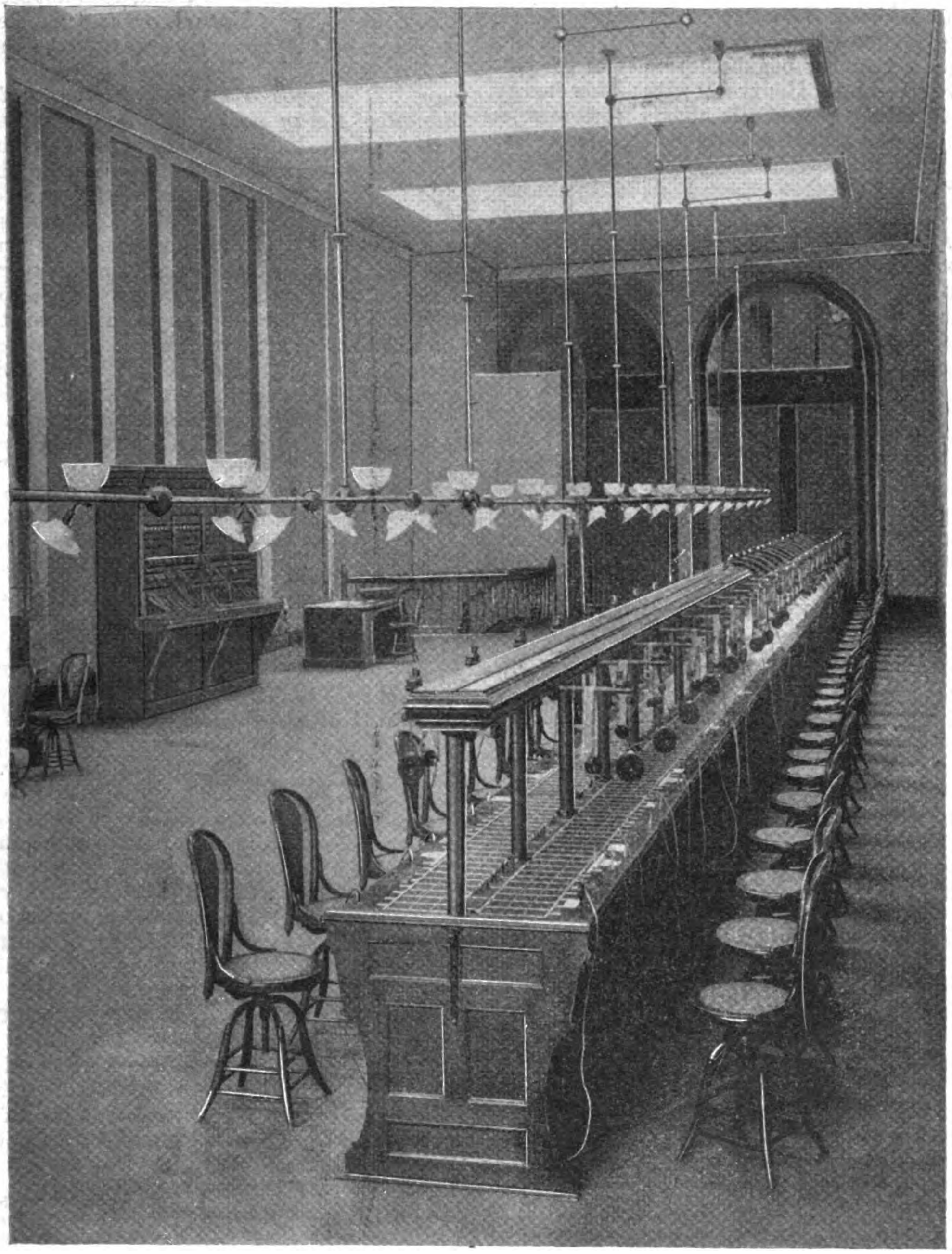


FIG. 6.—OPERATING ROOM.

The completion of this broadly planned work by the Bell Telephone Company of Philadelphia reflects great credit upon the directors and officers of the company.

If there still exist in Philadelphia any of that diminishing class of people who, perceiving that telephones are relatively simple and inexpensive instruments to manufacture, are under an impression that the construction, operation and management of a telephone exchange in a great city are also simple and inexpensive, they would discover much to modify or remove that impression through a visit to the new headquarters in Market street, and an inspection of the system now centering there.

LIGHTING THE WORLD'S FAIR.

PLANS adopted for lighting the buildings and grounds provide for 138,218 electric lamps, of which 6,766 are to be arc lamps of 2,000 c. p. each, and 131,452 incandescent, 16 c. p. each. The electric lighting will cost something like $1,500,000 and will be ten times as extensive as was employed at the Paris Exposition. The light and motive plant at the Exposition, it is estimated, will require 26,000 h. p., of which 22,000 will be required for the electric plant.

PROF. JAMES B. DE MOTTE, of the De Pauw University, Greencastle, Ind., lectured recently before the Montauk Club, Brooklyn, on "Electricity, the Wizard of the Nineteenth Century."

AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—IV.

BY

Mary A. Henry

IV.

And now let us go over the ocean to Faraday, and see how he asks the great question. Bence Jones tells us that as far back as 1824, Faraday began the study of the subject. "He believed"—as did Henry—"with all his energy, that as voltaic electricity powerfully affects a magnet, so the magnet ought to exert a reaction upon the electric current,"[1] and he makes an experiment which nearly makes the discovery.[2] He again makes experiments in November, 1825, December, 1825, and April, 1828, but without result. "*The momentary existence of the phenomena escaped him.*" "The good time was now come."[3]

In the beginning of the year 1831 comes over the sea Henry's paper in *Silliman's Journal.* It describes the magnets that have sprung up under Henry's hands, and the rules of their construction. Faraday, with quick philosophic instinct, sees in these powerful instruments for producing magnetism; means for a new trial of the old experiments, and again he goes to work. "He began his experiments on August 29, 1831."[4] Let us look at his apparatus. We see at a glance it is Henry's magnet, with its poles elongated, and the whole bent into the form of a ring. On the side B are wound the wires to convey the electric current for magnetizing the ring; there are "three lengths of wire, each about 20 feet long," insulated and wound as Henry taught Faraday to do in his paper in *Silliman's Journal.* These "three lengths" may be "connected as one," when the ring will be an "intensity" magnet, a long single wire; or, each of the three strands may be independently connected with the battery, when it will be a "quantity" magnet. Connected as one, the three strands are used by Faraday, and for the intensity magnet thus formed, if Henry's instructions are followed properly, there must be an "intensity" battery—a battery of many pairs of plates, and we find there is "*a battery of* 10 *pairs of plates, four inches square.*" On the A side of the ring is a wire, corresponding exactly to the wire surrounding the armature in Henry's experiment, and it is carried to a distance, and brought so near to a magnetic needle that upon the passage of the current it will oscillate, as did the needle in Henry's galvanometer. The essential apparatus; the means of the discovery used by the two men, like the discovery itself, is identical. Faraday saw his needle "oscillate," as Henry saw his "swerve" at the making and the breaking of the galvanic current. There is, however, a marked difference in the immediate mental attitude of the two men in regard to the observed phenomenon. Henry sees instantly that the question is answered. He says:

> "This experiment illustrates most strikingly the reciprocal action of electricity and magnetism, if it does not indeed prove their absolute identity. In the first place magnetism is developed in the soft iron of the galvanic magnet by the action of the currents of electricity from the battery, and secondly the armature, rendered magnetic by contact with the poles of the magnet induces in its turn currents of electricity in the helix which surrounds it. We have thus as it were *electricity converted into magnetism and this magnetism into electricity.*"

He immediately recognizes the condition essential to the production of electricity by magnetism—that is, *motion* or *change*. He tries other ways of producing the effect: "*slipping off the armature by degrees until the contact was entirely broken,*" dipping the battery plates but a little way into the acid at first, and afterwards immersing them by degrees, etc., all detailed in his paper, and then again he emphatically repeats his clear statement of the phenomenon:

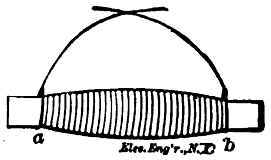
> "A current of electricity is produced for an instant in a helix of copper wire surrounding a piece of iron, whenever magnetism is produced in the iron. An instantaneous current, in one or the other direction, accompanies every change in the magnetic intensity of the iron."

Faraday, on the other hand, does not seem to have understood the reply of Nature, or at least he seems far from confident of it. He writes to a friend the 23d of September, "*I think that I have hold of a good thing; I cannot say. It may be a weed instead of a fish that after all my labor I may pull up.*" On the next day, September 24th, the third day of his experiments, he is again trying the effect of a helix of wire conveying the voltaic current of 10 pairs of plates, upon another wire connected with a galvanometer, and other like experiments, but "*no induction sensible.*" Had Faraday at this time discovered the essential nature of the phenomenon, experiments like these could not have failed, in his hands, to give conclusive results. "He gave up experiments for that day with the electromagnet and tried instead the effect of bar (permanent) magnets." An iron cylinder had a helix wound around it. The ends of the helix were placed between the poles of the magnet, arranged as in the accompanying figure. Every time the magnetic contact was made or broken there was motion in the galvanometer." Now, but not until now, he reaches a positive conclusion: "Hence here distinct *conversion of magnetism into electricity.*"

This constitutes his first distinct annunciation of the phenomenon, so that his discovery can scarcely, in justice, be said to have been made until this day, September, 24, 1831.

Not until the ninth day of experiment, October 17, does he produce the deflection of the needle by thrusting a bar magnet into a helix of wire; the experiment which came over to Henry in that brief paragraph of April, 1832, and which incited him to repeat his own experiments in the last two weeks of June of the same year. With no other knowledge of Faraday's work than this particular mode of producing the effect, it is curious to see Henry in these June days bending the armature of his magnet into a ring (see page 104 of this article), while on the other hand, Faraday, equally unconscious of Henry's efforts, in his paper of November, 1831, makes the important observation that "a soft iron bar, in the form of a lifter to a horseshoe magnet, when supplied with a coil of this wire, becomes, by juxtaposition with a magnet, a ready source of a brief but determinate current of electricity," thus adopting the precise method which had been employed by Henry.

Faraday, as Henry, desired that the electricity he could produce through magnetism might be manifested by a spark. An entry in his note-book of February 8, says:



Faraday's Apparatus for Producing a Spark from an Electromagnet.

> "This evening at Woolwich, experimented with magnet, and for the first time got the magnetic spark myself. Connected ends of a helix into two general ends, and then crossed the wires in such a way that a blow at *a b* would open them a little. Then bringing *a b* against the poles of a magnet, the ends were disjoined and bright sparks resulted."

It may be well to give in full Bence Jones's account of Faraday's work up to the 24th of September, so that the reader may be enabled to judge for himself whether we have interpreted it correctly. We break its thread, here and there, for comment, as we have already done with Henry's paper.

> "On August 29th, 1831, Faraday began his Electrical Researches."

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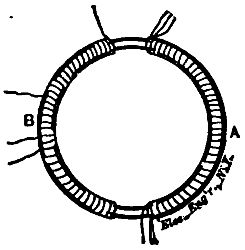
1. *Life of Faraday*, ii., 1.
2. Quarterly Jour. Science, July, 1825, p. 338.
3. *Life of Faraday*, ii., 2.
4. *Ibid*, ii., 2.

> "In December, 1824, he believed with all his energy that as voltaic electricity powerfully affects a magnet, so the magnet ought to exert a reaction upon the electric current. Guided by this idea he made an experiment, of which one part (the passage of a magnet through a metallic helix connected with a galvanometer), if separated from the rest of the experiment, would then have made the great discovery of magneto-electricity. This experiment he published in the *Quarterly Journal of Science*, July, 1825, p. 338."

The phenomenon, it will be noticed, was here actually produced under Faraday's hands, although unperceived by him. To use our former simile, he had failed to catch the moment when the gnome was at work.

> "In November, 1825, also, he had failed to discover voltaic induction. He passed a current through a wire, which was lying close to another wire, which communicated with a galvanometer, and found 'no result.' *The momentary existence of the phenomena of induction then escaped him.*
>
> "Again, Dec. 2, 1825, and April 22, 1828, he made experiments which gave 'no result.' These experiments were not published.
>
> "The good time was now come. The first paragraph in the laboratory note-book is 'Experiments on the production of electricity from magnetism.' His first experiment detailed in the second paragraph records the discovery by which he will be forever known.



Faraday's Inductive Ring.

> "'I have had an iron ring made (soft iron), iron round and ⅞ of an inch thick, and ring six inches in external diameter. Wound many coils of copper round, one half of the coils being separated by twine and calico: there were three lengths of wire, each about twenty-four feet long, and they could be connected as one length, or used as separate lengths. By trials with a trough each was insulated from the other. Will call this side of the ring *A*. On the other side, but separated by an interval, was wound wire in two pieces, together amounting to about sixty feet in length, the direction being as with the former coils. This side call *B*.'"

We here find Faraday working with an electromagnet made exactly in accordance with Henry's plan as given in his paper in *Silliman's Journal* of January of the same year. It is immaterial that Faraday's iron core is in the form of an endless ring instead of a horseshoe. That Faraday had carefully studied Henry's paper is shown not only by this use of Henry's system of construction, but in the publication of his results in the *Experimental Researches*, Nov. 31, 1831, he says:

> "'There is no doubt that the arrangements like the magnets of Moll, Henry and Ten-Eyck and others, in which as many as *two thousand pounds* have been lifted, may be used for these experiments.'"

Henry had introduced Moll's results, very much inferior to his own, with his paper in *Silliman's Journal;* and Ten-Eyck had been mentioned in Henry's paper as his assistant who had been engaged in constructing magnets under his personal direction. There were no others at work upon the subject. It was Henry's little giants Faraday saw in Henry's paper lifting the enormous weight of 2,000 lbs., and the notice, although couched in undiscriminating language, nevertheless makes it certain that the paper had come under Faraday's notice, and that he had learned the lesson it had to teach. Before the paper of Henry had reached his hands, the only electromagnet available for Faraday's use was Sturgeon's horseshoe bar, with its single loosely wound uninsulated helix of wire.

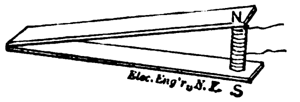
> "'Charged a battery of ten pairs of plates four inches square. Made the coil on *B* side one coil, and connected its extremities by a copper wire passing to a distance, and just over a magnetic needle (three feet from wire ring), then connected the ends of one of the pieces on *A* side with the battery: immediately a sensible effect on needle. It oscillated and settled at last in original position. On breaking connection *A* side with battery, again a disturbance of needle.'"
>
> "In the 17th paragraph, written on the 30th, he says: 'May not these transient effects be connected by causes of difference between power of the metals at rest and in motion in Arago's experiments?'"

The requisition of change or motion obviously occurs here, in a certain sense, to Faraday's mind, but only as a question. As the children say, Faraday is at this point "very warm" in this curious game of hide-and-seek, but the gnome is not yet caught, as we plainly see from the experiment next described. Faraday is even not absolutely sure that his ring produced the phenomenon, as the next paragraph unmistakably indicates:

> 'After this he prepared apparatus. Writing to his friend R. Phillips, September 23, he says: 'I am busy just now again on electromagnetism, and I think that I have hold of a good thing, but I can't say. It may be a weed instead of a fish that, after all my labor, I may at last pull up.'
>
> "September 24 was the third day of his experiments. He began paragraph 21 by trying to find the effect of one helix of wire, carrying the voltaic current of ten pairs of plates, upon another wire connected with a galvanometer. 'No induction sensible.'"

Faraday is here repeating the ring experiment; this time, to him, without apparent result.

"Longer and different metallic helices show also no effect." These experiments are essentially the same. In them, although unperceived by Faraday, magnetism must necessarily have produced electricity. With a conception of the necessary condition of change or motion (which, considering the failure of these experiments, could apparently have been but a passing thought) he has laid, as it were, his very fingers upon the result, yet it continues to elude him. Not sure of the glimpse he has had of it with his ring—that experiment repeated is apparently denying its former assertion while those other experiments fail. He is here evidently still baffled by the transitory nature of the effect and so is still failing to catch the moment when it is produced. Not yet can the discovery be said to have been made; since the very existence of the phenomenon was to this date still unproven. He gives up experiments for that day, and tries the effects of a bar magnet instead of the ring magnet that he had used on the first day. In paragraph 33 he says:



Faraday's Conversion of Magnetism into Electricity.

> "'An iron cylinder had a helix wound on it. The ends of the wires of the helix were connected with the indicating helix at a distance by copper wire. Then the iron placed between the poles of bar magnets as in accompanying figure. Every time the magnet contact at *N* or *S* was made or broken, there was magnetic motion at the indicating helix—the effect being, as in former cases, not permanent, but a mere momentary push or pull. But if the electric communication (*i. e.*, by the copper wire,) was broken, then the disjunction and contacts produced no effect whatever. *Hence here distinct conversion of magnetism into electricity.*'"

In this sentence we find the first positive recognition of the phenomenon; of its necessary condition of change or motion. Faraday has at last caught the moment when the gnome is at work; the discovery is made—but not in justice can it be said until this day, September 24, 1831.

Two or three other experiments follow, with helices of wire around a core of wood instead of iron, and, as we may conjecture, are successful, since the essential condition of the phenomenon is no longer a mystery. Then follows the experiment usually given in the text-books, as the one by which Faraday made the discovery.

> "'The fifth day of experiment was October 17. Paragraph 57 describes the discovery of the production of electricity by the approximation of a magnet to a wire.
>
> "'A cylindrical bar magnet, three-quarters of an inch in diameter and eight inches and a half in length, had one end just inserted into the end of the helix cylinder (220 feet long); then it was quickly thrust in the whole length, and the *galvanometer* needle moved; then pulled out, and again the *needle moved*, but in the opposite direction. This effect was repeated every time the magnet was put in and out, and therefore a wave of electricity was so produced from *mere approximation of a magnet;* and not from its formation *in situ.*'
>
> "The ninth day of his experiments was October 28, and this time he 'made a copper disc turn around between the poles of the great horseshoe magnet of the Royal Society. The axis and the edge of the disc were connected with a galvanometer. The needle moved as the disc turned.' The next day, November 4, he found

'that a copper wire, one-eighth of an inch, drawn between the poles and the conductors produced the effect.' * * *

"In ten days of experiment these splendid results were obtained. He collected the facts into the first series of *Experimental Researches in Electricity.* It was read Nov. 24th, at the Royal Society. Then he went to Brighton."

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—IV.

BY

Francis B. Crocker and S. S. Wheeler.

CHAP. III.—*Continued.*

Series Dynamo on Constant-Current Circuit.—The connections in this case (Fig. 8) are extremely simple, the armature, field-coils, amperemeter, main circuit and lamps, all being connected in one series.

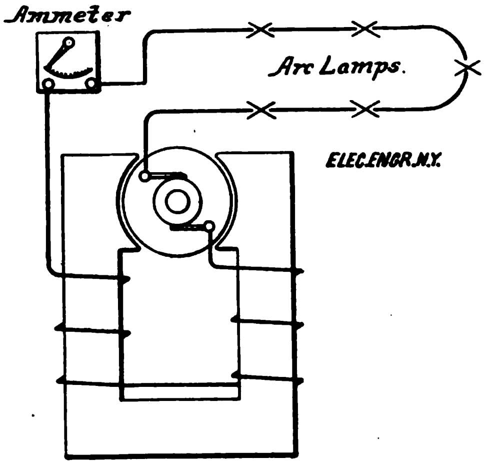


FIG. 8.—SERIES DYNAMO ON CONSTANT CURRENT CIRCUIT WITH LAMPS IN SERIES.

Alternating-Current Plant.—The proper connections in this case are shown in Fig. 9, in which the names of the different parts of the plant are given and which therefore requires no explanation.

The diagrams of connections of all cases of *dynamos coupled together* and of *electric motors* are given in the chapter on Starting where they are required to explain the proper steps.

CHAPTER IV.

DIRECTIONS FOR STARTING DYNAMOS AND MOTORS.

General.—Make sure that the machine is clean throughout, especially the commutator, brushes, electrical connections, etc. Remove any metal dust, as it is very likely to make a ground or short circuit.

Examine the entire machine carefully and see that there are no screws or other parts that are loose or out of place. See that the oil cups have a sufficient supply of oil, and that the passages for the oil are clean and the feed is at the proper rate. In the case of self-oiling bearings see that the rings or other means for carrying the oil work freely. See that the belt is in place and has the proper tension. If it is the first time the machine is started it should be turned a few times by hand, or very slowly, in order to see if the shaft revolves easily and belt runs in centres of pulleys.

The brushes should now be carefully examined and adjusted to make good contact with the commutator and at the proper point, the switches connecting the machine to the circuit being left open. The machine should then be started with care and brought up to full speed gradually if possible, and in any case the person who starts either a dynamo or motor should closely watch the machine and everything connected with it and be ready to instantly shut down and stop it (and throw it out of circuit if it is connected) if the least thing seems to be wrong, and should then be sure to find out and correct the trouble before starting again. (See "Locating and Remedying Troubles.")

Starting a Dynamo.—In the case of a dynamo it is usually brought up to speed either by starting up a steam engine or by connecting the dynamo to a source of power already in motion. The former should of course only be attempted by a person competent to manage steam engines and familiar with the particular type in question. This requires special knowledge acquired by experience, as there are many points to appreciate and attend to, the neglect of any of which might cause serious trouble. For example, the presence of water in the cylinder might knock out the cylinder head; the failure to properly set the feed of the oil cups might cause the piston rod, shaft or other part to cut, or other great or small damage might be done by ignorance or carelessness. The mere mechanical connecting of a dynamo to a source of power is usually not very difficult; nevertheless, it should be done carefully and intelligently, even if it only requires throwing in a friction clutch or shifting a belt from a loose pulley. To put a belt on a pulley in motion is difficult and dangerous, particularly if the belt is large or the speed is high, and should not be tried except by a person who knows just how to do it. Even if a stick is used for this purpose it is apt to be caught and thrown around by the machinery unless it is used in exactly the right way.

It has been customary to bring dynamos to full speed before the brushes are lowered into contact with the commutator, but there is no particular reason for this practice, provided the dynamo is not allowed to turn backwards, which sometimes occurs from carelessness in starting, and might injure copper brushes by causing them to catch in the commutator. If the brushes are put in contact before starting they can be more easily and perfectly adjusted, and the E. M. F. comes up slowly so that any fault or difficulty will develop gradually and can be corrected, or the machine stopped, before any injury is done to it or to the system. In fact, if the machine is working alone on a system and is absolutely free from any danger of short-circuiting any other machine or storage battery on the same circuit, it may be started up connected to the circuit, in which case the E. M. F. and current feel their way, so to speak, through the whole system, and any trouble manifests itself so slowly that it can be taken care of before serious injury results.

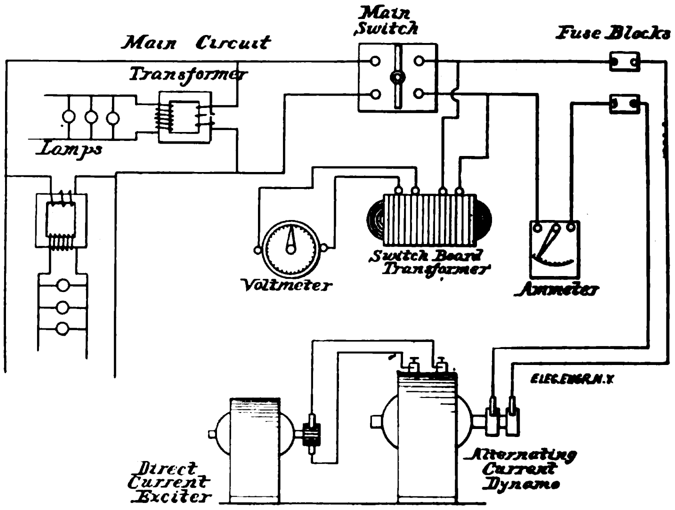


FIG. 9.—ALTERNATING CURRENT PLANT.

If, however, a dynamo is to be connected to another or to a circuit having other dynamos or a storage battery working upon it, the greatest care should be taken. In fact, this coupling together of dynamos can be done perfectly if exactly the correct method is followed, but is likely to cause serious trouble if any mistake is made.

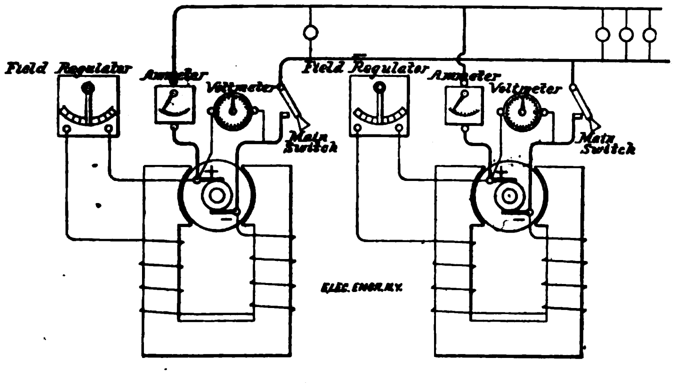


FIG. 10.—SHUNT DYNAMOS IN PARALLEL.

Coupling Dynamos.—Two or more machines are often connected to a common circuit. This is especially the case in electric lighting where the number of lamps required to be fed varies so much that one dynamo may be sufficient for certain hours, but two, three or more machines may be required at other times.

Dynamos may be connected together either in parallel (multiple arc) or in series.

Dynamos in Parallel.—In this case the + terminals are connected together or to the same line and the — terminals are connected together or to the other line. The currents (*i. e.*, amperes) of the machines are thereby added but the E. M. F. (volts) are not increased. The chief condition for the running of dynamos in parallel is that their voltages should be equal but their current capacities may be different. For example: A dynamo producing 10 amperes may be connected to another generating 100 amperes, provided the voltages agree. Parallel working is therefore suited to constant potential circuits. A dynamo to be connected in parallel with others or with a storage battery must first be brought up to its proper E. M F., speed and other working conditions, otherwise it will short circuit the system, and probably burn out its armature. Its field magnetism must also be at full strength owing to the fact that it generates no E. M. F. with no field magnetism. Hence it is well to find whether the pole pieces are strongly magnetized by testing them with a piece of iron, and make sure of the proper working of the machine in all other respects before connecting the armature to the circuit. It is quite common for the field circuit to be open at some point and thus cause very serious results. In fact, a dynamo should not be connected to a circuit in parallel with others until its voltage has been tested and found to be equal to or slightly (not over 1 or 2 per cent.) greater than that of the circuit. This test may be made by first measuring the E. M. F. of the circuit and then of the machine by one voltmeter; or voltmeters connected to each may be compared. Another method is to connect the dynamo to the circuit through a high resistance and a galvanometer, and when the latter indicates no current it shows that the voltage of the dynamo is equal to that of the circuit. A rougher and simpler way to do this is to raise the voltage of the dynamo until its "pilot lamp," or other lamp fed by it, is fully as bright as the lamps on the circuit, and then connect the dynamo to the circuit. Of course the lamps compared should be intended for the same voltage and in normal condition. Be sure to connect the + terminal of the dynamo to the + wire and the — terminal to the — wire, otherwise there will be a very bad short circuit.

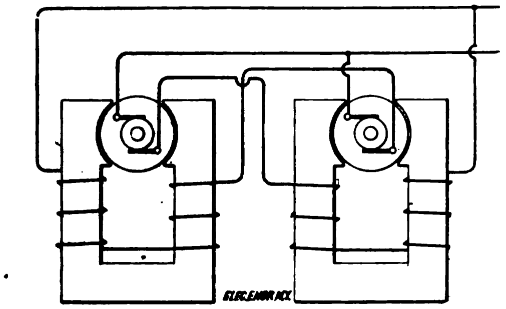


FIG. 11.—SERIES DYNAMOS IN PARALLEL.—MUTUAL ACTION.

When the dynamo is first connected in this way it should only supply a small amount of current to the circuit (as indicated by its ammeter) and its voltage should then be gradually raised until it generates its proper share of the total current.

If the voltage of the dynamo is less than that of the circuit, the current will flow back into the dynamo and cause it to be run as a motor. If it is shunt wound the direction of rotation is the same, however, and no great harm results with a slight difference in voltage. Shunt machines are therefore particularly suited to being run in parallel, Fig. 10.

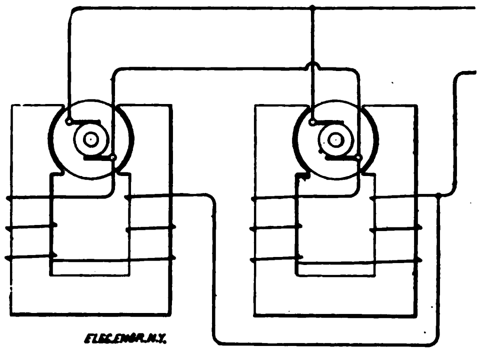


FIG. 12.—SERIES DYNAMOS IN PARALLEL.—EQUALIZING WIRE.

Series Wound Dynamos in Parallel.—If the machine is series wound, this back current would cause a reversal of field magnetism and motion which is very objectionable. In fact, series dynamos in parallel are in very unstable equilibrium, because if either tends to generate too little current that very fact weakens its own field which is in series, and thus still further reduces its current and probably reverses it. One way to run series dynamos in parallel is to cause each to excite the other's field magnet, as shown in Fig. 11, whereby if one generates too much current it strengthens the field of the other and counteracts itself, so to speak.

The other way, Fig. 12, to run series dynamos in parallel, is to connect together the two + brushes by what is called an "equalizer," as well as the two — brushes. By this means the electrical pressure at the terminals of the two armatures is made the same, and the currents in the two fields are also made equal. Series machines are not often run in parallel, but the principles just explained help the understanding of the next case, which is important.

ELECTRIC HEATING IN SWITZERLAND.

THE Maloja Kursaal on the Engadine is to be heated electrically during the winter by power derived from the Mera river in Aseima. There is no doubt that considerable use will be made of electric heaters in those cases where natural power is abundant, and it is probable that this department of electrical engineering will become exceedingly important in such cases.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XIII. NEW YORK, FEBRUARY 10, 1892. No. 197.

The philosopher who discovered the scientific principles upon which the electromagnet is founded, and who invented the form of apparatus best adapted to demonstrate these principles, must be regarded by the whole world as having made the chief contribution towards the application of electromagnetism to the various wants of man.—Scientific American.

THE EDISON AND THOMSON-HOUSTON CONSOLIDATION.

FOR several years past rumors have been current from time to time of impending consolidations or coalitions of leading electrical companies. Several such reports have been verified by the absorption or control of several companies by others of more commanding position; but the most striking and significant event of the kind, so far, is the proposed consolidation of the Thomson-Houston Electric Company and the Edison General Electric Company. A stockholders' agreement for such a consolidation was drawn up a few days since, by prominent officials of the two companies and was printed in full in some of the daily papers of Saturday, February 6. The agreement, to be effectual, requires the assent of a majority of the stockholders of both companies on or before May 1, 1892. The terms of the agreement involve the surrender of stock in the present companies to be replaced by stock in the proposed new company on the following basis (quoted from the agreement as published):

(*a*) Shares of the stock of the Edison Company shall be exchanged in full payment for shares of common stock in the new corporation, share for share.

(*b*) Shares of preferred stock of the Thomson-Houston Company shall be exchanged in full payment for shares of preferred stock of the new corporation, at the rate of four shares of the old stock (par $25 each) for one share of the new (par $100 each).

(*c*) Shares of common stock of the Thomson-Houston Company shall be exchanged in full payment of common stock of the new corporation at the rate of five shares of the old stock for three of the new.

The new corporation is to have a capital stock of $50,000,000, in 500,000 shares of $100 each, of which not more than 20 per cent., may be preferred stock, entitled to receive dividends of 7 per cent. per annum, cumulative, but without preference as to principal. The corporation is to have the right to acquire stock, property and rights of other corporations or individuals. It is provided in the agreement that after the issue of stock to holders of shares in the present companies "further issues of stock shall be made only for the general purposes of the company." A committee is appointed to carry out the project, consisting of the following gentlemen:—J. Pierpont Morgan, D. O. Mills, H. McK Twombly, Fred. L. Ames, T. Jefferson Coolidge and H. L. Higginson. The agreement also contains the following:—

> Instead of a new corporation, any existing corporation may, in the discretion of the Committee, be selected and reorganized so as to provide for the substantial accomplishment of the purposes of this agreement.

The figures of the last annual reports of the Edison and Thomson-Houston companies give the capital stocks issued, respectively, as follows:

THOMSON-HOUSTON.		
Common stock	$6,000,000.00	
Preferred stock	4,000,000.00	
		$10,000,000.00
EDISON.		
Stock (1,000,000.00 in treasury)		15,000,000.00
		$25,000.000.00

The issue of stock in the proposed new company, according to the published agreement, would result as follows:—

To Edison shareholders—and the treasury.		
Common, share for share		$15,000,000.00
To Thomson-Houston shareholders—		
Preferred, four (@ $25) for one (@ $100)		4,000,000.00
Common, five (@ $25) for three (@ $100)		14,400,000 00
Total capitalization for the existing companies merged		$33,400,000.00
Making preferred	$ 4,000,000 00	
Common	29,400,000.00	
and leaving in the treasury:—		
Preferred stock	$ 6,000,000.00	
Common stock	10,600,000.00	
		$16,600,000.00

The agreement if carried into effect by the assent of a majority of shareholders of both companies will thus result in an increase in capitalization of $8,400,000.00 over that of the two companies as they stand, and will leave the way open to a further increase of $16,600,000.00.

The primary object of such consolidations is, of course, to increase the profits of shareholders through the reduction of the expense of administration and management, as well as the abatement of onerous competition in selling. The former of these means of increased revenue can doubtless be accomplished by the proposed amalgamation of the Thomson-Houston and the Edison Companies—but there is much room for doubt in respect to the latter. To say nothing of several less conspicuous companies actively competing for business, the Westinghouse Company would seem to be in a good position to contest the ground with the proposed new combination. If, as is confidently asserted, the Westinghouse Company has satisfactorily completed its reorganization and can, with adequate capital, keep the field against the Edison and Thomson-Houston Companies, combined, the element of strenuous competition in prices will be likely to continue to be an important factor in the situation for an indefinite period.

The proposed capitalization of the new company will doubtless be deemed excessive by conservative financiers. The combined earnings of the two companies, as per their last reports, would seem to justify the proposed capitalization; but investors appear to have a deeply rooted desire for dividends rather than for the accumulation of a surplus expended in the building up of a great corporation. It is understood that during the past year, the Edison General Co. earned net \$1,650,000 (it paid out about \$1,200,000 in dividends), while report has even placed the Thomson-Houston net earnings at about \$2,500,000, though it does not appear that anything like such a sum has yet been available for dividends.

We do not regard the projected combination as likely to be injurious to the many smaller companies and individuals engaged in electrical manufacturing or dealing. Competition in prices can hardly be more severe than at present, and should the new company, as seems not unlikely, seek to maintain and strengthen prices, rather than to reduce them further, that policy could not fail to result in benefit to well-established concerns which have meritorious products to offer to the public.

THE PHILADELPHIA TELEPHONE EXCHANGE.

One after another, in close succession, the telephone exchanges in the large cities are being reconstructed to meet the requirements of larger and better service, and upon plans embracing both improved and new devices evolved from the experience of the past fifteen years. The introduction of the telephone to public service, like that of electric lighting, was so rapid and extensive that the accessories of an exchange, both as to housing and apparatus, were, perforce, extemporized for the most part as they best might be. Nowhere can the contrast between an early crude "central," with its maze of overhead wires, as well as its ponderous signaling and connecting machinery and a well-equipped exchange of the present day be better exemplified to an observer than in the new building apparatus and underground lines of the Bell Telephone Co. of Philadelphia, which we have the pleasure to describe in other columns of this issue. The complete system, planned by Dr. Samuel M. Plush, general manager of the company, and carried out under his supervision, includes interesting features of novelty in devices and arrangement. Especially noteworthy is the extreme condensation effected in the operating apparatus. Another impressive fact is the magnitude of investment in entire reconstruction. There are many features that have to be taken into account in a modern exchange of which little was thought in the earlier days. The underground system alone is a new element of enormous costliness, especially when taken in conjunction with the use of metallic circuits. Altogether we can but congratulate our telephonic friends in Philadelphia on the largeness and liberality with which they have laid their plans and carried them out.

MR. TESLA BEFORE THE LONDON INSTITUTION OF ELECTRICAL ENGINEERS—AND THE ROYAL INSTITUTION.

(*Special Cablegram to* The Electrical Engineer.)

On the evening of February 3, Mr. Nikola Tesla, by special invitation, delivered a lecture on the results of his latest investigations before the London Institution of Electrical Engineers.

After a short introductory as to the theory which led him up to his new line of work, involving the application of enormously high potentials and frequencies far exceeding those heretofore employed, Mr. Tesla began his experimental demonstrations with the exhibition of various forms of discharges. He showed first an induction coil operated by condenser discharge. With this coil he produced various remarkable discharge phenomena. Among others he imitated the spark of a Holtz machine and showed a brush discharge covering an area of something like 4 or 5 square feet, and also a luminous wire outlining the name of William Thomson. Mr. Tesla then took up some very novel and exceedingly interesting phenomena discovered by him some time ago consisting of a brush rotating in an exhausted globe. He showed that the brush was affected electrostatically, magnetically (even by the earth's magnetism), and that the study of these phenomena might lead to important discoveries as to the nature of electrostatic or electromagnetic fields.

Mr. Tesla showed how Crookes' well-known radiometer is set in motion *at ordinary atmospheric* pressures with alternating high potentials, thus affording another link in the chain of evidence which is gradually establishing the truth of modern views.

The subject of obtaining motive power was next taken up by Mr. Tesla, who exhibited a motor running on one wire and also without any connection with the generator, and the lecturer also dwelt on the possibility of running motors without wires.

Mr. Tesla next spoke of the construction of light-giving bulbs and the manner in which the dissipation of the energy supplied is prevented in the bulb by screening and allowing it to be dissipated only from the point at which it is wanted. In this connection he brought before his audience the results obtained with "carborundum," the new diamond-like substance recently produced by Mr. E. G. Acheson, of Monongahela, Pa.

Mr. Tesla then proceeded to show an interesting experiment which consisted in bringing a button to incandescence in a tube, holding the latter in the hand, and with another tube he repeated the experiment of Prof. Crookes by bringing a small platinum wire in the tube to incandescence and rotating a small fan.

Mr. Tesla also dwelt on phosphorescence and concluded his address with a demonstration of the luminous effects produced upon tubes in an electrostatic field.

On the following evening Mr. Tesla repeated his lecture before the Royal Institution by invitation.

Some idea of the interest aroused by Mr. Tesla's lecture may be formed from the fact that the London *Times* went to the unusual length of devoting a column editorial to it and publishing a very full report of it, with a description of his more striking demonstrations.

TESTS OF GLASS AND PORCELAIN INSULATORS.

BY

F. W. Jones

I CHEERFULLY comply with the wish expressed by Mr. Henry Stott, in THE ELECTRICAL ENGINEER of February 3, and the accompanying tables give some measurements I have made on insulators.

On March 1, 1891, I placed two new ten-pin cross-arms side by side on a fixture about 8 feet above the roof of Nos. 5 and 7 Dey street, New York, exposed to the weather on all sides, besides chimney smoke and condensed steam from exhaust pipes. On one arm I placed 8 English-made porcelain insulators and two brownstone earthenware, of a pattern very similar to our American double petticoat screw glass. On the other arm I placed 10 new glass insulators of the latter style. The porcelain insulators were kindly loaned to me by Mr. I. W. Gladstone of Mr. Edison's laboratory.

After a lapse of over nine months I connected the insulators on each arm, respectively, together by a copper wire in the same manner as they would be connected in actual use, and from each set I conducted an okonite wire highly insulated down through the building to my testing-room. The leakage of the leading wires was nearly negligible.

	10 Glass.	8 Porcelain and 2 Brownstone.	
1891.			
Dec. 24.	*Ohms.*	*Ohms.*	Raining and mist.
11:00 A. M.	334,000	835,000	Varying.
11:30 "	242,000	835,000	
2:00 P. M.	308,000	975.000	
3:00 "	240,000	1,000,000	
4:15 "	278,000	1,063,000	
Dec. 25.	*Megohms.*	*Megohms.*	
Noon.	1,410	1,030	Dry, overcast.
Dec. 26.	*Ohms.*	*Ohms.*	
11:30 A. M.	200,000	590,000	Fog and rain.
12:00 M.	337,000	900,000	
1:00 P. M.	234,000	900,000	Varying slightly.
3:00 "	147.500	510,000	
4:00 "	178,700	737,000	
Dec. 28.	*Megohms.*	*Megohms.*	
11:30 A. M.	30,000	15,000	Clear and very dry.
1892.			
Jan. 2.	*Ohms*	*Ohms.*	
10:30 A. M.	875,000	1,000,000	Driving rain for several hours past.
1:00 P. M.	430,000	1,250,000	
Jan 12.			
11:30 A. M.	215,400	560.000	Mist and rain.

	8 Glass of the above.	8 Porcelain of the above.	
Jan. 14	*Ohms.*	*Ohms.*	
11:00 A. M.	15,230,000	22,400,000	Cloudy.
2:30 P. M.	536,000	1,720.000	Mist and rain.
4:00 "	2,000,000	5,360,000	Varying, clearer.
4:30 "	1.900,000	6,830,000	" "
5:00 "	2,234,000	6,830,000	Cloudy, slightly dry and no rain
Jan. 15			
10:30 A. M.	1,260,000	7,650.000	Snowing, temp. 38°, damp, sticky.
12:00 P. M.	1,730,000	8.600,000	
1:20 "	4,300,000	14,500,000	Stopped snowing.
3:00 "	21,700,000	30,000,000	Clearing.
Jan 18.			
10:30 A. M.	1,300,000	3,510,000	Misty, clearing.
12:45 P. M.	775,000	2,070.000	Raining, variable.
2:00 "	6,000,000	16,000,000	Clearing.
4:30 "	390,000	1,300,000	Very damp, misty.
Jan. 19.			
11:00 A. M.	5,200,000	17,750,000	Damp, variable.
4:00 P. M.	3,875,000	17,200,000	" "
Feby. 3.			
3:30 P. M.	38,750,000	155 000,000	Rained last night. Overcast, wind moderate

NOTE: Persons desiring the temperature and moisture of atmosphere on above dates can secure them at the U. S. Signal Office.

The results, I think, are entirely in accord with those in the very exhaustive paper read before the Society of Telegraph Engineers in London in March, 1878, by Mr. John Gavey. It will be noticed that the porcelain insulators do not rise so quickly nor so high in insulation after the atmosphere dries up, and this, strangely enough, is a virtue, rather than a vice, as our long circuits work clearer and quicker when their electro-static charges have a chance to become dissipated along the route, instead of emptying themselves at either end of the wire to the earth. It has been the case on long overland circuits through a dry country, that artificial leaks have had to be employed, as is well known. Our multiplex circuits work better in damp than in clear, frosty weather; but the hygroscopic peculiarities of glass cause such a leakage of the signaling current that it readily falls below an efficient margin in the relays of the receiving station, so that the quicker working of the wire can lend no aid. Of course it will be seen that a loss of 50 per cent. of the received current will decrease the working force on the armatures of the relays more than 50 per cent., but not quite as the squares as shown by Prof. Silvanus Thompson in his splendid book on electromagnets.

It is strongly contended by some well-informed electricians in this country that electricity not only escapes to earth by the points at which the telegraph wire is supported on the poles, but also directly from the wire through the mist or fog enveloping such wire, and some have gone so far as to apply an insulating paint to the wire to cut off this leakage. I have made tests in heavy fogs with large galvanized plates in close proximity to earth plates, and have failed to detect the slightest variation of a Thomson astatic mirror galvanometer of 7,758 ohms resistance unshunted with 100 volts, the surface exposed to fog being equal to nearly half a mile of galvanized iron wire. Perhaps some of your readers may have had opportunities to test this matter more thoroughly and can throw light on the subject.

THE IRON ROOFS OF THE EDISON STATION, HAZLETON, PA.

BY

J. Edwin Giles.

It is remarkable that among the splendid class of men who constitute the close student and the practical engineer so little should be known of the iron roof as a covering for electric stations. At the rebuilding of this station about two years ago it became the duty of the writer to decide between iron and other material as a protection against fire, for the double reason, first, to remove the expensive insurance and, second, to give confidence to our customers in the matter of reliability. I corresponded with a number of persons throughout the country with the hope of obtaining information that would be of value to me, but the information received was so contradictory that it proved of no value whatever. I determined, however, to adopt iron trusses and corrugated iron roof, holding open a good road, however, for retreat, should disaster overtake us. Mr. Braddell's article in THE ELECTRICAL ENGINEER of Jan. 6, calling attention to the good and bad features of iron roofs is timely. I believe Mr. Braddell visited this station one bright morning following a cold night close upon the completion of the roof, and had the editor of THE ENGINEER been present on this or other like occasions he never would have gotten off the classic phrase "dropping from their iron roofs like a heavy dew," as the dropping was of the magnitude of a veritable rain-storm. The entire cement floor was thoroughly wet from this dropping. The dynamos covered with canopies and the belts with pouches made the dynamo-room look like a Japanese bazar. The letter by the Milliken Bros., in the issue of January 13, has but one reasoning, to wit, that an iron roof is only fit to be used on a barn or other building where the temperature of the interior can be kept about the same as the exterior. The roof builder and company manager must not forget that the men who live under these roofs are as sensitive to atmospheric changes as are the gentlemen who spend their busy hours in steam-heated offices. The experience of Mr. Robt. Amory, manager of the Brookline Gas Light Co., is interesting and valuable. But would not a little further experiment at the hands of Mr. Amory with the material in his roof be further instructive? What would have been the result had the slate been removed from his roof, leaving the cork to take care of condensation within a room such as he depicts, with temperature of the outside ten degrees below zero, as it has been here for the last three nights? Again had the cork been left off the iron, and the slate and iron been separated by a few inches, what would have been the result? In my opinion there would have been no condensation on the inner iron, as I can see no reason why the outer slate should act differently from an outer iron roof. Our engine and dynamo room is 40x60 feet, the walls are of brick, side walls 19 feet high and gables 30 feet to apex, trusses and purlins iron, and No. 26 corrugated roof, the latter having five coats of paint on the inside. Central on this roof is a ventilator 15x38x4 feet, the sashes of which are manipulated from the floor of the room. No moisture could penetrate this roof except by condensation, as every crevice was carefully closed, and yet I have seen icicles hanging from the inside of this roof eight inches long. As an experiment I had a small section of lining or interior roof put in just under and close to the truss rafter, leaving about five inches of air space between this and the corrugated roof. The lining is galvanized iron with standing seams tied to purlins and rafters. The visible side is without projections, except along the inside of walls, which is worked into a neat cornice forming a trough which conveys water either from condensation or leakage to a conductor and the sewer. This proved a splendid success. On occasions when the outer roof would send down a shower of dewdrops this lining was perfectly dry; not the least moisture could be discovered on close examination. We have lined the entire roof, and even on our coldest nights there has never been a particle of sweating on this iron lining, although we have positive evidence that the under surface of the outer roof still acts as a condenser. This remedy is comparatively cheap, light, handsome and effective, and not the least—is fireproof.

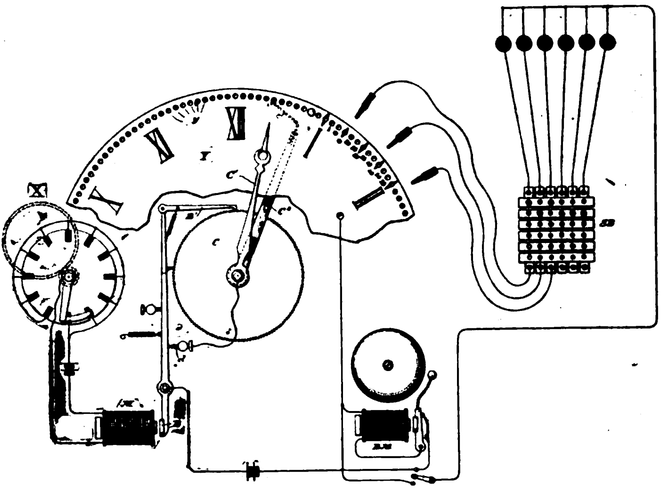
DELANY ELECTRICAL REMINDER OR SIGNALING APPARATUS.

We illustrate on this page a recent invention by Mr. Patrick B. Delany, which should prove an important addition to the numerous electrical appliances which have become so useful and convenient as to render them almost indispensable. Mr. Delany's device is, broadly, an electrical reminder, or alarm, intended for use in offices, stores, factories, residences or hotels.

The twelve hours on the dial are divided up into five-minute sections, so that by the use of plugs an alarm may be set in advance for any time during the day or night, and as many alarms may be set as there are holes in the dial, twelve to each hour.

By the use of the switchboard calls may be set for any time for any room in a house, factory or hotel. On reaching his office in the morning the business man may provide against any lapse of memory and insure all his engagements for the day by sticking plugs in the holes corresponding to the time for which his appointments were made; and at his home at night before retiring he may, with the same facility, arrange to wake up his cook, coachman, guests and himself at whatever hour of the morning that may be predetermined.

The operation of the reminder is very simple. A clockwork X causes a trailing contact maker to make a complete revolution hourly. In its path are twelve segments corresponding to intervals of five minutes. When the trailing finger makes contact with a segment the magnet M is energized and the hand C is pushed forward five minutes at a time. On the same arbor with the hand, and back of the dial, is another contact arm, flexible at its end. This contact arm partly overlaps the holes in the dial. If there be a plug in its path the circuit of magnet B M is closed and the trembling bell rung, so long as the armature lever B of M remains in contact with *d*, or while the trailing finger of X is passing over a segment. This duration may be regulated to any length desired, depending as it does on the size of the segment.



Delany Electrical Reminder.

The plugs for connecting distant calls are so insulated as to prevent contact with the dial, making contact with the contact arm only.

FLY-WHEEL ACCIDENTS IN ELECTRIC LIGHT STATIONS.

In an admirable address on "Centrifugal Force and Resulting Phenomena," delivered by the eminent engineer, Mr. Chas. E. Emery, before the students of Sibley College, Cornell University, the speaker dwelt upon the comparative frequency of fly-wheel accidents, which he showed could in part be traced to the comparatively high speeds at which engines are now being operated, but more especially to the higher strains on material now found desirable under the spur of competition to produce increased work in engines of a given size by the use of higher steam pressures.

Mr. Emery then proceeded to deduce a number of valuable formulæ for calculating the strength of fly-wheels, and then described several accidents due to the bursting of fly-wheels. The description of an accident of this nature which occurred at the station of the Lynn, (Mass.) Electric Light & Gas Co. will prove of more than ordinary interest to electrical engineers and station managers, as it involves questions not only of a mechanical but of an electrical nature as well, and which were brought out in the suit instituted against the insurance company for the non-payment of the loss sustained. We quote from Mr Emery's address as follows:

The engine was provided with cylinders 20 and 30 inches in diameter each with 48 inches stroke of piston and connected to a crank at one end of the fly-wheel shaft. The surface condenser was of the Wheeler independent form with independent circulating and air pump, the station being near an arm of the sea. The fly-wheel was 20 feet in diameter with 40 inches face, and was said to weigh 38,000 pounds. It was belted directly to a jack pulley on a shaft near the centre of the building, a little way in front of the cylinders. The passage in front of the cylinders was under the slack side of the belt and over the tight side which ran underneath the floor at that point. The jack shaft was continued by several lengths of line shafting connected by friction clutches and carried pulleys belting directly to the dynamos.

The accident occurred in October, 1890, in connection with a small fire in the tower of the building from which the conductors for arc lamps were carried out to the pole lines. A swath was cut through the roof and both sides of the building, and at least one piece of the fly-wheel was carried fully 150 feet horizontally across a vacant lot and a railroad track, wrecking the corner of a house and falling alongside the cabin of the watchman at the railroad crossing. Fortunately no deaths resulted from this accident, though two men were temporarily injured by flying pieces.

Interest in the case has been renewed by a suit brought by the electric company against the insurance companies for reimbursement for all the damages that occurred, not only from the fire directly, but those due to the wrecking of the engine. In connection with Mr. Manning, of the Amoskeag Mills, and Mr. C. J. H. Woodbury, vice-president of the Boston Manufacturers' Mutual Fire Insurance Co., the speaker was engaged as an expert by the insurance companies. It is thought that it will be of interest to briefly state the points claimed by each side in this very interesting litigation, for the reason that all were dependent on electrical and mechanical engineering principles combined in an unusual way.

The insurance law in Massachetts is understood to be that insurance companies are responsible not only for the fire but for all damage directly occasioned by the fire. The burden of proof is, however, on the insured to show that the losses other than those from the fire itself were actually occasioned by the fire. The plaintiffs in this case did not, therefore, attempt to account for the fire in the first instance, but endeavored to show that such fire caused all the damage, they claiming that the fire caused a short circuit in the tower by enveloping the plates of the lightning arresters in flame and possibly expanding them so that they came in contact. They claimed that this short circuit was brought on so suddenly that it broke the pulley operating the dynamos then in use, that pieces of this pulley flew and hit others, and, according to one phase of the theory, one of the pieces broke off one ball of the governor so that the engine ran away and caused the damage; and according to another phase, providing for the fact that the loss of one ball would not disable the governor, it was assumed that the jar due to breaking the first pulley caused the next pulley to break, and that the next, and so on from pulley to pulley across several undisturbed bearings and a friction clutch attachment, a distance of about 30 feet, until the jack pulley was thus broken, and that then pieces of this were carried by the belt under the fly-wheel and broke that, causing the wreck.

On the part of the defendants it was only necessary to disprove the probability of the assumptions, but in addition affirmative proof was presented to show that the conditions indicated a defect in the governor belt and that the damage to the machinery was simply due to the running away of the engine. The disaster occurred between 1:30 and 2 A. M. when current was being supplied for only 95 arc lights and for incandescent lights in the station. The arc lights were operated by two 50-light Thomson-Houston dynamos, such lights being distributed in four circuits from the station, which were, however, coupled two and two in series so as to form one circuit for each machine. Both dynamos were operated by one pulley on line shaft, the belt to the pulley of the farther dynamo running over the driving pulley on the top of the belt from the other dynamo. A similar pair of dynamos were running on open circuit at the time, and in addition an alternating dynamo and exciter for the same were in operation to light the station. There were at the time only two men in the engine and dynamo room and a third man in the fire-room adjoining. The testimony of all was to the effect that one discovered the fire in the tower and that another who was busy wiping shafting came and inspected it. The statements were to the effect that up to that time everything was working smoothly. It was stated that one called out to the fireman to blow the whistle and then turned on the fire alarm near another entrance to the building, and that the watchman after inspecting the fire went to the throttle valve of the engine. It was claimed that suddenly there was a tremendous roar indicating a short circuit. The evidence of the firemen would imply that the roar continued for some time, but the testimony of the engineer was to the effect that coincidentally therewith the pulley driving the two dynamos went to pieces and that immediately other pulleys commenced to fly and that he left the building. The watchman claimed that he had started to shut steam off the engine, for a reason not clearly explained, but that the pulleys commenced to fly and he, though struck by a flying fragment, bounded over a gate out of another entrance.

All the experts agreed that the first effect of short circuiting a Thomson-Houston arc dynamo is to materially increase the load due to the increase of current, but that such load is very soon brought back to the normal by the action of the current regulator. The efforts of the plaintiffs were to show that the short circuit, being an electrical phenomena, brought an instantaneous shock on the dynamo, which was transmitted through the belt from the dynamo to the operating pulley on the main shaft. Instances were cited showing that a belt operating a dynamo had in several cases been run off in this way, and in one instance the belt became foul with the operating pulley in such a way as to crush it. An important point arose as to the time it required the dynamo regulator to act and reduce the current; several of the witnesses claiming that it required 10 to 15 seconds, and all agreeing that this time would vary with the condition of the apparatus and the amount of damping afforded by the fluid in the cylinder attached to the regulator.

As a method of accounting for the short circuiting, the plaintiffs presented a diagram of the lightning arresters in the tower. There was one connected in each outgoing and each incoming conductor of each circuit, and as there were four circuits in use there were, therefore, eight lightning arresters involved. The four circuits were, however, as stated, coupled up at the time to make two, one for each machine; that is, the current going out from one terminal of the dynamo came back to the switchboard instead of to the dynamo, and was directed out on another circuit and brought back to the dynamo through the second terminal of the second circuit. To account for the short circuiting it was claimed that the fire filled the whole tower with flame, which, as it contained carbon, was a conductor and short circuited the dynamos by enveloping the segments of the lightning arresters. It was also claimed that in due time such segments became sufficiently expanded by heat to be brought in actual contact and thereby make a metallic short circuit. It was further claimed that fragments of carbon from the burning woodwork dropped between the horns of the lightning arresters and thus short circuited them, and that in one or more of these several ways the several lighting arresters were connected to form a short circuit.

In response, the defendants urged the improbability of any such action. Such a short circuit could only take place by grounding both branches of each circuit through two lightning arresters at the same time. The fire was localized in the vicinity of two of the arresters which were on the same circuit, but such circuit was connected in series with another, so that if short circuited it would only cut out about half the lights in the double circuit; or one-fourth of the whole. Two other lightning arresters of the four circuits were near and two more were on the opposite side of the tower where there were few signs of fire. It was clearly shown that to short circuit all the lights through the lighting arresters the segments of at least four widely separated must be in contact or the space bridged by flame or dropping sparks at exactly the same instant; and if this were done by flame it was necessary that the flames, which would naturally roll around and show alternately flame and smoke as in any fire, should form forks of conducting flame sufficient to form a short circuit at four to eight different points in the tower at exactly the same instant. Any less mysterious coincidence would only short circuit one pair of lightning arresters, and cut out about half the lights on one dynamo, or, roughly, one-quarter of the whole, and if this operation were repeated shortly after, another quarter would follow, and so on, and instead of a sudden shock it would be a series of small shocks quite insufficient, even on the theory of the plaintiffs, to cause the damage. It was shown that the quadrants of the lightning arresters would be expanded at a temperature of 1,200 degrees, sufficient to be brought in contact, but it was difficult to suppose that the flame was at a sufficiently high temperature to expand all at the same time when the fire was confined to one corner of the tower. Ordinary flame has a temperature, according to the books, of 790 degrees, for the reason that currents of air are commingled with it in order to carry on the combustion with a material developing so much hydrocarbon gas in the process of combustion. Brass melts at about 1,950 degrees, and it is well known that brass cannot be melted in an ordinary wood fire, but requires a blast with charcoal or other solid combustible. The brass was not melted, so the highest temperature obtained in the hottest corner of the tower was therefore less than 1,950 degrees, and much less elsewhere.

It was further claimed on the part of the defendants that the fracture of one pulley would not necessarily fracture the next one on the line, and that of the next and so on, and produce the train of breakages in the order claimed by the plaintiffs. The plaintiffs showed that one of the piers of the line shaft alongside the first pulley that broke was fractured, and claimed that this was done by that pulley fouling at the time of the short circuit, bringing a jar on the pillow block, which caused the disruption of the next pulley and that in turn the next, but this was answered by the fact that no other pier was injured and that no great shock could be transmitted beyond the next journal. There were two journals before reaching the two on either side of the jack pulley, neither one of the four being disturbed, and a friction clutch intervened. The defendants claimed that the pieces of the first pulley which it was in testimony flew up and struck the ceiling and the switchboard could not in the limited height available spread very greatly, and that therefore no piece of the first pulley could fly off at an angle of 40 to 45 degrees for a distance of about 40 feet and break the governor of the engine at the outset, and it was stated that if it did the engine would still be under control.

(*To be continued.*)

Mr. Walter C. McKinlock, secretary and treasurer of the Southern Electric Supply Co., is contemplating a trip to the cities of Mexico and Florida, combining business with pleasure.

ON THE LAW OF HYSTERESIS.—III.

BY CHARLES PROTEUS STEINMETZ.

II.—MAGNETIC CIRCUIT BUILT UP OF WELL INSULATED LAYERS OF VERY THIN SHEET-IRON. (FIG. 2, TABLE III.)

With this magnetic circuit tests were made for the frequencies 85, 138 and 205, and on *open* magnetic circuit for the frequency 138, and gave the following results:

TABLE III.

	Frequency in complete periods per second: N:	Number of readings:	Exponent of power, found by tests: X:	Coefficient of Hysteresis, found by tests: η:	Magnetization B covered by the observed values: from:	to:	Average difference between the observed values of hysteresis H, and the values calculated by the law: $H = \eta B^{1.6}$:
Closed magnetic circuit:							
1.	85	9	1.6041	.00285	5910	17,940	±4.4%
2.	138	14	1.6044	.00335	5220	19,320	±2.8%
3.	205	9	1 6970	.00373	6360	16,700	±3.4%
Open magnetic circuit:							
4.	138	8	1.6040	.00393	3150	12,280	±3.4%

Herefrom it seems that the consumption of energy by hysteresis per magnetic cycle increases with increasing frequency—that is, with increasing velocity of the magnetic change.

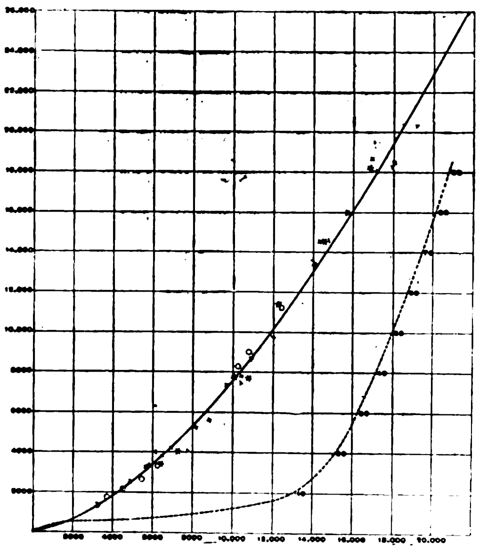


FIG. 2.

The three values of three coefficients of hysteresis for closed circuit in their dependence upon the frequency N, can be expressed by the *empirical* formula:

$$\eta = (.0017 + .000016\,N - .00000003\,N^2)$$

To compare the values of hysteretic loss for different frequencies, in Fig. 2 the curve of hysteretic loss for $N = 100$ complete periods per second is plotted, giving:

$$\eta_{100} = .003\text{; hence } H = .003\,B^{1.6}.$$

and the observed values of H are not directly drawn in, but the observed values of H multiplied with the factor: $\frac{\eta_{100}}{\eta_{\text{obs.}}}$ to compare the different frequencies with each other.

These values are plotted for:

$N = 85$ with the mark Y } closed magnetic circuit.
138 " " +
205 " " *
$N = 138$ with the mark o; open magnetic circuit.

Especially noteworthy is the last set of readings, on open magnetic circuit, in so far as it proves the fallacy of the general opinion that the hysteretic loss of energy in the iron is smaller in the open magnetic circuit than in the closed circuit.

For the coefficient of hysteresis observed on open magnetic circuit $\eta = .00393$ is even greater than that for closed magnetic circuit, $\eta = .00335$

But this discrepancy is easily explained by the fact that in the closed magnetic circuit the magnetization is nearly uniform throughout the whole iron. But in the open magnetic circuit the magnetic field intensity differs considerably from point to point, being a maximum in the middle of the magnetizing coils, a minimum at the ends of the iron sheets. Now, the values of B given in the table, are the average values of the magnetization, and the values H, the average values of hysteretic loss. But the average value of the 1.6th powers of different qualities B is larger than the 1.6th power of the average value of B.

Taking this into account, it seems that the loss of energy due to hysteresis depends only upon the intensity of magnetization and perhaps upon the frequency, but is independent of open or closed magnetic circuit, as is to be expected.

A third set of determinations of the hysteretic loss of energy was made on a magnetic circuit built up in the same way as in the tests, Table II, but of pieces of sheet-iron .0686 cm. in thickness.

Here with this thicker kind of iron, evident proof of the induction of eddy-currents in the iron was found.

The method of determination, the apparatus, etc., were essentially the same as in the other set of tests. In calculating these tests, the law of the 1.6th power was assumed as true, and the loss of energy in the iron expressed by the equation,

$H = \eta B^{1.6} + \varepsilon N B^2$, where $H_1 = \eta B^{1.6}$ is the true hysteretic loss per cycle and cm³., which is independent of the frequency, and $H_2 = \varepsilon N B^2$ is the loss of energy by eddy-current, per cycle which is proportional to the frequency N.

From this expression $H = H_1 + H_2$ the coefficients η and ε were calculated and the agreement or disagreement of these coefficients η and ε allow us now to check the correctness or incorrectness of the law of the 1.6th power, Table IV.

TABLE IV.

No.	Frequency, in complete periods per second: N.	Number of readings.	Coefficient of hysteresis, found by tests; η.	Coefficient of eddies, found by tests; ε.	Magnetization B, covered by the observed values. From:	To:	Average difference between the observed values of loss of energy in the iron, and the calculated values.
1.	78	6	.00331	$.751 \times 10^{-6}$	4171	16,050	±1.9%
2.	140	6	.00331	$.730 \times 10^{-6}$	4880	17,200	±2.2%
3.	207	5	.00336	$.757 \times 10^{-6}$	2710	18,200	±1.6%

The values found for η are so nearly alike that we can consider them as constant, and take their mean value $\eta = .00333$ as the coefficient of hysteresis.

Even the values found for ε are not much different from each other, not more than was to be expected from the unavoidable differences in the temperature of the iron, which because of the high electric temperature-coefficient of iron makes ε rather variable.

Taking the average of ε, we derive $\varepsilon = .746 \times 10^{-6}$ and as the formula of iron loss, $H = .00333\,B^{1.6} + .746 \times 10^{-6}\,N B^2$.

Two other sets of determinations of the hysteretic loss of energy, for the frequency 170 complete periods per second, were made on two laminated horse shoe magnets, with laminated keeper or armature, each of 2660 cm.³ of iron, of 70 cm.² cross-section, the thickness of the iron sheets being .0405 cm.

The method of observation and of calculation was the same as in Table III., and the same precautions were taken. In the first set of readings, considerable eddy-currents were found; in the second set only a small amount of eddies. In the first set of tests, the number of readings was 14;

as coefficient of hysteresis found: $\eta = .0045$
" " " eddies " $\varepsilon = 1.16 \times 10^{-6}$,

while the range of magnetization was from 842 to 2,600 lines of magnetic force per cm², the average difference between observed and calculated values = ± 2.8%.

WHAT THE WORLD IS WAITING FOR.

IT is reported that a new electric motor is now on exhibition in San Francisco which is expected to supersede all the present motors now used for transportation purposes. The electricity is said to be generated in batteries which can be made of any size and shape required, and that all the chemicals used can be recovered and worked over again indefinitely. This motor is said to be very cheap, easily managed, and capable of doing almost anything that can be required of it. In fact, it seems to be the very thing for which the world is waiting.—*San José Herald.*

Letters to the Editor.

CLAUSIUS' LAW OF ENTROPY.

In your editorial on Mr. Steinmetz's paper an erroneous statemen is made of Clausius' Law of Entropy. The law should be stated as follows: A number of physical processes which form a complete cycle never diminishes the total entropy of the bodies which are involved in these processes. If the cycle is not reversible then the total entropy is increased and heat is developed at the expense of some other form of energy. *Vice versa*, if heat is necessarily developed at the expense of some other form of energy then the cycle is non-reversible. By such a cycle the entropy is increased. Hysteresis of iron is only a special case of non-reversibility. It is therefore easily seen that Clausius' Law of Entropy does not represent all processes of nature as irreversible as your statement of it seems to imply.

M. I. Pupin.

New York City.

We are very glad to take notice of Dr. Pupin's letter and willingly accept his suggestion, that Clausius' Law of Entropy be expressed in its negative form, that is, "The change of entropy cannot be negative," instead of stating it in the positive form, namely, "The change of entropy must be positive," so as to include the ideal case in which the entropy equals zero, though they practically amount to the same in the end.

Theoretically the Law of Entropy is expressed thus,

$$\int \frac{d\,Q}{T} \geqq 0$$

where T is the absolute temperature, and Q the quantity of heat, and the sign of equality corresponds to the completely reversible, and that of inequality, to the non-reversible, cyclic process.

Nevertheless the completely reversible process, that is, the complete conversion of one form of energy into another and back again, with an efficiency of 100 per cent., has only an ideal or theoretical existence, since nature's cyclic processes seem to be all non-reversible If a reversible cyclic process existed, we could complete it over and over again without either gaining or losing energy, and therefore have perpetual motion, which experience shows us we can never attain.—Eds. E. E.

THE SPREADING OF FIRE IN CENTRAL STATIONS.

Is there an element about an electric generating station or about any building where electric light or power wires are used, that makes them burn more *rapidly* than other buildings? That is the question that is now agitating the minds of fire underwriters. The belief has been suggested many times in the past on account of the reported rapid spread of fires and the extensive damage done before they were subdued. I call to mind several instances during the past few years, notably, the burning of the Providence Narragansett Co.'s station, the Boston Edison station, the New York Manhattan station and more recently the Chicago Arc Light & Power station. In December last the large fire in the wholesale shoe stores on Federal St., Boston, is believed by some to owe its origin, rapid spread and great destructiveness to the presence of "electric wires" in the building. Last month a one story brick electric car house 100 x 150 feet in Toledo, Ohio, was entirely consumed with a large number of electric cars, and a fortnight later the Ferdinand St. station of the Boston Electric Light Co. was nearly destroyed. I have seen a sensational and interesting account of the Toledo fire in which the particulars were stated about as follows: The fire was discovered about 3 o'clock in the morning by the car cleaners. It was described by a colored man, I think, who first saw it, as a "small blue flame" burning on the seat of one of the cars. He endeavored to extinguish it with "buckets of snow" (a most effective piece of fire apparatus). There was a howling snowstorm raging outside. In an incredibly short time the fire spread from this car and seemed to instantaneously extend over the whole car house with a "strange hissing noise" and the occupants of the building had to beat a precipitate flight for life. The rapid spread with the strange hissing noise are the mysterious characteristics of this fire and they are supposed to have been due to the presence of the trolley wires and incandescent lights in the building. It is plain to my mind that the rapid spread after the fire had burned out of the car where it was first seen, and where they must have tried for some minutes at least to extinguish it, is precisely what would have taken place if the same building had contained the same number and kind of horse cars or even *mule* cars, with the same raging storm outside, and *inside* of course, and that if the wires had not been there the strange hissing noise would not have been suggested, although the same noise would have been there. It has also been insinuated that the embarrassed financial condition of the company aided the spread of the fire. That theory of course would explode the mysterious electrical hypothesis. Knowing nothing about either I should think one about as probable as the other. It is more than probable, however, that the presence of a reliable system of automatic sprinklers covering the entire inside of the building, together with available hose and water and a few level heads and hands to use them, would have stopped the fire or confined it to one car, electric wires and financial condition notwithstanding.

Now to come to the Boston Ferdinand St. fire. This started in the early morning and certainly did spread rapidly and most completely to every part of the building which is about 100 x 60 feet and 3 stories high. There was evidently a needless delay in calling the fire department but still, with all that, it seems improbable that the fire could so completely have communicated to, and burned with such fierceness, in all parts of the building without some unusual aid or uncommon conditions. The inside construction was heavy, rough, spruce timbers and joists with double 2 inch wood floors. The ceiling of this first floor (engine room) was sheathed with soft wood and the brick walls bare. The walls and ceiling both in the second floor (dynamo room) were similarly sheathed, while the walls and ceiling of the third floor (supply room) were both bare. Not only is the sheathing almost entirely consumed but the joists and floor boards underneath, in every room, and even under the engine room floor next the ground, are burned and charred an inch or more in depth, and no part of the building seems particularly more burnt than another.

It cannot be denied that this thin, soft wood sheathing, dried and seasoned by the heat of a large station for over two years, was terribly inflammable and would "burn like tinder" (as it really was), and that the spread would be accelerated by the excessive air currents caused by engines, fly-wheels, belts and dynamos of a 1400 arc light station; but still, is that all there is to the question? With all conditions of building the same, with the same engines, fly wheels, belts and speed operating the same number of machines for producing mechanical instead of electrical power would the results of the fire have been the same?

Here were 25 arc machines (24 Brush, 1 T-H.) We know that arc dynamos spark and that the electric spark liberates ozone, because our olfactories tell us of the ozonic presence. We know that it permeates all parts of such a station as this and that it affords several times more support for combustion than does oxygen. Is then the fierceness and rapid spread of these fires due to the disintegration of oxygen and consequent increased support for combustion? Admitting for the sake of argument that there is a greater fierceness and more rapid spread, are the causes those above suggested? And if not, what are they?

Without expressing any further opinion I would like to see the subject analyzed and treated by some of our many eminent scientists engaged in the electrical business.

The presence of unusually dangerous conditions not only in electric generating stations but *wherever electric wires are installed* is fast taking root in the fire insurance mind, and it certainly behooves the electrical interests to demonstrate that there is no foundation for such beliefs, if indeed there is none, else there is trouble ahead in the increased cost and difficulty of procuring fire insurance.

If there is foundation for the belief, the remedy must be applied in the way of appropriate construction and fire protection, or the fiddler must be paid.

Stephen E. Barton.

Boston, Mass, Feb. 2, 1892.

EFFECT OF THE VAN DEPOELE vs. DAFT DECISION.

Your interest in patent practice and the welfare of inventors has doubtless drawn your attention to the decision in *Van Depoele* vs. *Daft*, on page 520 of the Official Gazette, Jan. 26, '92.

The decision speaks for itself and very plainly too. It is matter of history that for many years the most glaring frauds were perpetrated through the agency of a perverted application of the law in the matter of reissued patents. This, however, was finally exploded by the Supreme Court of the United States and then it was that the divisional application began to flourish.

Several decisions of the Commissioners of Patents have been aimed at divisional applications, beginning with *ex parte Holt*, most of them being for the protection of the public and to prevent inventors from practically extending the *term* of their patent beyond seventeen years by hatching out a divisional application every few years.

The present decision, however, disposes of the practice under which an applicant was allowed to take a rib from the parent case, complete the skeleton, and then clothe it with a mantle of claims sufficiently broad to cover the subsequent growth of the art, claiming the date of the *filing* of the original, or parent, application as the age of his new creation. Under these circumstances an old application which has been skilfully kept alive in the Office year after year, in defiance of the law, was worth its weight in gold, as no subsequent *actual* inventor could, by any possibility, overcome the so-called "record date" of this buried treasure, which thereby became an invincible weapon by which further progress in the art was practically prevented.

Frankland Jannus.

Washington, D. C., Jan. 30, 1892.

CARBON STUBS AS FUEL.

In visiting the various arc light stations throughout the country, one notices barrels and boxes filled with carbon stubs which have been carefully saved and stacked up for no apparent reason and occupying valuable space. It has not been my fortune to find a station superintendent who could give any reason for their preservation, except possibly that some carbon manufacturer would some day call them in, and finding some way of utilizing them, allow a difference in trade.

As no such offer has yet been made, this saving process still continues. It may be of interest to know that they make a very slow, even, hot and smokeless fire when burned in a grate, stove or under a boiler, and that Mr. Hill Williams of the Upper Appomattox Co., of Petersburg, Va , has toasted his shins in his office for some time by this kind of a fire. When his water wheels do not get sufficient water, he burns them under his boiler, and a few shovels full of them make it very difficult to keep his safety valves from deafening the neighborhood.

NEW YORK CITY, Feb. 2, 1892. JEAN A. WETMORE.

PRACTICAL FORMULÆ FOR STREET CAR MOTORS

In your issue of Dec. 23, Mr. Thorburn Reid concludes his article thus : "Having found *w*, ... we may substitute ...... *E*. We are thus enabled to determine the size of wires ...... for feeders. Will you kindly inform me (1) if *E* is not a fixed E. M. F. (500 volts), and (2) how the E. M. F., *E* determines the size of the feeder wires ; (3) in equation (1) if n = revs. per *minute* why the equation does not read $E = \frac{S_2 N n}{60}$? Should it not be n = No. of revolutions per second?

SUBSCRIBER.

BALTIMORE, MD.

NOTE BY MR. THORBURN REID.

I HOPE the following explanations will make clear to "Subscriber" the difficulties he has found in my article.

(1) The E. M. F. in the formula is that which is impressed on the terminals of the motor. It is therefore the E. M. F. of the line at the point where the car is running. The standard E. M. F. for street railways is 500 volts *at the station*, but if it is 500 volts at the station, it must be less than that at any point on the line where current is being taken off, on account of the $C R$ drop on the line.

(2) Having determined by means of the formulæ in my article the E impressed on the motor terminals required to drive the car at a fixed speed, we subtract this value from the fixed E at the station which may be somewhat more or less than 500 volts, and thus obtain the value of the $C R$ drop on the line. Then, having determined the current flowing along the line to the different cars supplied by it, we may determine the resistance of the line and hence, knowing its length, the diameter of the wire required to give this resistance.

(3) Writing n as revolutions per minute was an oversight either on my part or the printer's. Equation (6) gives the value of n in revolutions per second. This oversight however would not affect the results obtained from equations (4) and (8), since all constants in equations (1) or (2) are included in a in equations (8) and (4).

In the ENGINEER of January 20, Mr. Arner finds an apparent discrepancy between formula (4) of my article and that given by Kapp. Kapp's formula is an approximation, as is mine. He gives, a little before the page cited by Mr. Arner, the formula:

Electrical efficiency of motor $= \frac{e}{E}$ and says very truly that that formula is not exact enough for his purpose. which is to obtain a formula for the *commercial* efficiency of on electric railway, including generator, line and motor. Kapp's formula is not exact and, under certain conditions, would not give as accurate results as the formula $\frac{e}{E}$.

It would take more space than the limits of this communication would permit to go thoroughly into the question of the losses in transmission from generator to car axle, but I think I can briefly reconcile the apparent discrepancies Mr. Arner has found. w, as stated in my article is the work done by the motor. This work is partly expended in overcoming the friction of the motor bearings and gears. The remainder may be called the useful work, since it is expended only in driving the car. It is the ratio of this useful work to that supplied to the generator that Kapp intends to obtain by his formula. His formula would give that value exactly, however, under only one particular set of conditions. w in my article includes all the work done by the motor, whether in its own bearings and gears or on the car axle. It also includes the magnetic, or hysteresis and eddy current loss in the core of the armature. This fact does not affect the accuracy of equations (3) and (4) for the reason that equation (9) $w_1 = b n$ is as nearly correct for these internal losses as for the external, except the magnetic loss, which is so small a proportion of the total as to be entirely negligible, especially in such rough calculations as these must be.

THORBURN REID.

SCHENECTADY, N. Y.

CONCERNING ELECTRICAL WRANGLES.

On behalf of all the readers of electrical matter in the daily papers I beg to interpose a respectful but firm objection to the trial at the present time, of the Morse—Vail telegraph controversy in the columns of the *Evening Post*. If we have got to sit as judges in this sort of thing, we want to do the work decently and thoroughly and regularly and in order; and we do not see therefore why, when the calendar of like cases already before us is so great, why when our judicial faculties are already over burdened, this particular row should be advanced out of its proper succession and suddenly sprung on us. Both sides have been hard at work evolving pleasing and suitable testimony for the last fifty years and we submit that plainly, and in no possible circumstance, can this be regarded as a "short cause." Look at this list of merely some of the more important cases which choke our calendar in the electrical field alone. I put the names of the parties first and the issue adjacent:

(1) John Doe (unknown Chinaman,) *vs.* Flavio de Gioja, Mariner's Compass. (2) Vieta *vs* Gilbert, The Earth's Magnetism. (3) Wall *vs.* Von Guericke, The Electric Light. (4) Hauksbee *vs.* Davy, Electric Illumination. (5) Musschenbroeck *vs.* Cunæus, *vs.* Von Kleist, The Leyden Jar. (6) Franklin *vs.* Dahliard, *vs.* De Romas, Identity of Lightning and Electricity. (7) Galvani *vs.* Sulzer *vs.* Volta *et al.*, Galvanic Cell. (8) Ritter *vs.* Nicholson and Carlisle, Electro-decomposition. (9) Ritter *vs.* Erman *vs.* Planté, Secondary Battery. (10) Romagnesi *vs.* Oersted, Magnetic Action of Current. (11) Sturgeon *vs.* Arago, Electro Magnet. (12) Henry *vs.* Faraday, Magneto Induction. (13 Watson *vs.* Ronalds *vs.* Wheatstone *vs.* Cooke *et al.*, Electric Telegraph. (14) Dal Negro *vs.* Davenport *vs.* McGawley *et al.*, Electric Motor. (15) Davidson *vs* Jacobi *vs.* Page *vs.* Hall *vs.* Lilly, Electric Railway. (16) De Moleyns *vs.* Starr, Incandescent Lamp. (17) Hjorth *vs.* Varley *vs.* Siemens *vs.* Wheatstone, Self-Exciting Dynamo. (18) Pacinotti *vs.* Gramme, Ring Armature. (19) Michell *vs.* Coulomb, Laws of Magnetism. (20) Jordan *vs.* Spenser *et al.*, Electro-Metallurgy. All of these far outdate the Morse-Vail dispute. Since then we have added and quite recently: Brush *vs.* Faure, Storage Cell. Bell *vs.* Reis *vs.* Gray *vs.* Drawbaugh, Telephone; and Edison *vs.* Everybody, Everything.

Of course when we go into other fields there are the fights over the telescope, (Galileo *vs.* Jansen); the locomotive, (Stevenson *vs.* Evans); the steamboat, (Fulton *vs.* Hulls, *et al.*); the screw-propeller. (Smith *vs.* Stevens, *et al.*); the monitor turret, (Timby *vs.* Ericsson) and plenty of others.

The Chinaman *vs.* Gioja discussion has been going on now for about 700 years and it has not been reached and formally submitted to us for decision even yet. At the same rate the Morse-Vail question ought not to come up regularly until some time in the latter half of the twenty-sixth century. Let us leave it to the readers of the papers of that date.

PARK BENJAMIN.

32 PARK PLACE, NEW YORK, 15th January, 1892.

WASHING AND SCRUBBING ELECTRIC CAR TRACKS.

In your last issue Mr. W. R. Mason says in regard to my article on the effect of a clean track that a well-adjusted broom will "fill the bill" equally as well.

I must take exceptions to this, because in certain cases the track broom (which, by the way, I had considered as part of the necessary equipment of every car, and did not mention on that account) does considerably *more* than fill the bill.

If Mr. Mason should ever be so unfortunate as to ride over some of the country roads where the cars run at a speed of ten or twelve miles an hour and find the track broom turning the car into an amateur cyclone of dust, I am sure he would be convinced of the wisdom of watering the track, for comfort if not for economy.

Besides, it is almost impossible to run a car thus without getting the journals hot and delaying traffic, to say nothing of injuring the vital parts of the motor. The actual cost of spreading the water is slight compared with the benefit got from it, and with its use the track broom is made much more effectual.

LUCIUS E. MARPLE.

NEW YORK CITY, February 4, 1892.

UNREASONING PREJUDICE AGAINST ELECTRIC LIGHT AND POWER.

I DESIRE to call your attention to the two enclosed clippings both taken from the Springfield *Daily Republican*, of Springfield, Mass. The one referring to the fire in the Holyoke Street R. R. Co.'s car shed shows the entire trend of the paper and that it is prejudiced against the electric industries. This is not the first time that it has thrown discredit upon the electric light by claiming that the wires were the cause of the fire. In two distinct cases where it claimed that the electric light wires were the causes of the fires the morning after they occurred, it has been proved that such was not the case. In the case of the fire in the Holyoke Street R. R. car shed the treasurer of the Company told the writer that he had never for a moment any suspicion that the fire was caused by electric light wires. Regarding the second slip referring to the "Rise in Insurance Rates," the writer is not aware whether the statement made in the last paragraph correctly represents the sentiment of the insurance people, yet judging from the facts, it does not seem possible that it could. According to the "Chronicle Fire Table," out of 22,412 fires in 1890, only 121 were caused by electric wire and lights, while 1,239 resulted from defective flues, 697 from explosions (of lamps, lantern, etc.), 223 from cigars, cigarettes and tobacco pipes, 269 from gas jets and 691 from matches.

It does not seem from the above facts that it is fair to assume that electric apparatus is to blame for the great increase of fires during the last year, and the daily press should be more careful in making statements that are detrimental to the great industries which have grown out of the use of electric apparatus. It would also be well to keep in mind the important aid rendered the firemen by electric apparatus in giving prompt notice when fire occurs.

ARTHUR J. NEWELL.

HOLYOKE, MASS., Jan. 26, 1892.

Personal.

MR. FRANK B. RAE.

THE well-known electrical engineer above named has recently made such arrangements that he is now free to engage in engineering and consultation work, as announced in our advertising pages. Mr. Rae, of whose interesting career we gave a sketch some months ago, was one of the very first electrical engineers in this country to give attention to electric traction; and the result is that both his work and his name are now familiar to all. Mr. Rae will, hereafter, as before, make a specialty of electric railway work, and he will also be ready to take up any questions in the electrical transmission of power and in the design of new electrical machinery for power transmission purposes. Plans and specifications will be fully drawn out by Mr. Rae, and supervision of work given by him. Mr. Rae has taken offices in the Hammond Building, Detroit. It is interesting to know that Mr. Rae is already engaged on some new and important railway work that promises well.

Obituary.

GEORGE WORTHINGTON.

NEWS reaches us from Buffalo of the death there of Mr. George Worthington, at the residence of his brother, after a lingering illness of about two years. It is seldom that any industry loses a man so active and prominent as the electrical industries lose in Mr. Worthington, who deserves the title of the pioneer of weekly electrical journalism in America. He was born in East Bethany, Genesee County, New York, March 18, 1844, of good stock, his family having been prominent in the interior of the State for years. He attended school at the Genesee and Wyoming Academy, at Alexander. N. Y. In 1862, he went to Milwaukee, Wis., and engaged in the hardware business until April, 1864, when he enlisted in the Fourth United States Infantry and served until the close of the war. He returned to Owego, N. Y., and then again to Milwaukee, Wis., where he again entered the hardware business, under the firm name of Worthington & Meek. Subsequently Worthington was appointed Consul to Ghent, Belgium. He soon resigned that position, returning home, went to Pittsburgh, Pa., where he was in the employ of the Pennsylvania Railroad Company for a short time. He then came to New York and entered the employ of W. H. Eldred, of the Gold and Stock Exchange Telegraph Company, and remained there until he founded *The Electrical Review*, in February, 1882. He never married and is survived by his father and by his brother, Mr. C. G. Worthington, of the insurance firm of Worthington & Sill, Buffalo, N. Y.

At the time Mr. Worthington founded his paper, there was no other weekly electrical journal in America. THE ELECTRICAL ENGINEER, then a monthly, had preceded it by but a few weeks, and the only other paper in the field was *The Operator*, a telegraphic journal, which did not drop that title and come out as *The Electrical World* until about the middle of 1883. Mr. Worthington had many bright newspaper ideas, and a wonderful talent for making friends, and the *Review* was soon on a very prosperous footing. Its work in aiding the development of the telephone, the electric light and all the later industries is known to all. To Mr. Worthington as editor of the *Review*, and in association with Mr. Charles W. Price, belongs a large part of the credit of establishing the National Electric Light Association and the New York Electric Club—a forerunner of many like organizations all over the country. Mr. Worthington was also a charter member of the American Institute of Electrical Engineers, but was never active at all in its affairs, his tastes and sympathies inclining him more to social and commercial, rather than technical, activities and pursuits. It may well be doubted whether any man in electrical work during the last ten years had a wider circle of acquaintances or was held in more affectionate esteem by them all. Yet he was a good fighter withal, and as to his qualities in active work it is enough to say that during all the heat and hurly burly of the last decade—certainly the most important that electrical applications have seen—he more than held his own.

GEORGE E. MUMFORD.

GEORGE E. MUMFORD, of Rochester, N. Y., died last week in Florida, aged sixty years. Mr. Mumford was born in the central part of the State and was the son of William Mumford, one of the pioneers of central New York. George E. Mumford was a graduate of Williams College, and was a lawyer by profession. He practised law for many years in Rochester in association with George H. Mumford, who was largely interested in the Western Union Telegraph Company in its earlier history when it had its headquarters in Rochester. In the latter years of his life Mr. Mumford abandoned the practice of law, confining his attention to many business enterprises with which he was connected. He was president of the Brush Electric Light Company of Rochester, which purchased the Genesee Falls and used the water-power to furnish Rochester with electric light, a plan that has proved to be very successful.

HENRY CHURCH.

IT is with much regret we announce the death from la grippe of Mr. Henry Church, of the Phœnix Iron Works, Meadville, Pa., builders of engines, etc., for electric lighting and power. Mr. Church was the son of Judge Gaylord Church, and was born in Meadville in 1842. He began as a civil engineer, and about 20 years ago consolidated the business interests of Dick & Church and the Phœnix Iron Works Co., of which concern he remained active manager down to the time of his death, witnessing the gradual and solid expansion of the industry he himself did so much to develop. Mr. Church was a high Mason, and took a keen interest in Masonic matters. His death was rather sudden, and came as a shock to the community that had known him from childhood and in all the honored relationships of life.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE 61th meeting will be held at the headquarters of the institute, 12 West 31st street., near 5th Ave., on Tuesday evening, February 16th, at 8 o'clock. A paper will be read by Lieut. F. Jarvis Patten, on "A Proposed New System of Alternating-Direct Current Transformation." Members who are especially interested in this subject may secure advance copies upon application to the secretary, which will be forwarded at the earliest possible moment. Distant members are invited to contribute their remarks in writing, in case they are unable to be present.

PAPERS TO BE READ AT THE N. E. L. A., BUFFALO CONVENTION.

Below we give a list of the papers to be read at the Buffalo Convention of the National Electric Light Association :

How to Fire a Steam Boiler	Richard Hammond.
The Allied Powers	Daniel Ashworth.
Switchboards: Their Safety and Operation	M. C. Sullivan.
Aerial Wires	E. F. Peck.
The Alternating Motor	Wm. Stanley, Jr. L. B. Stilwell.
From the Tannery to the Dynamo	Chas. A. Schieren.
Underground Wiring	E. A. Leslie.
Underground Systems	J. B. Craven.
Municipal Franchises for Quasi-Public Works	Allen R. Foote.
Electric Lighting from a Financial Standpoint	Erastus Wiman.

A SPECIAL TRAIN FOR THE BUFFALO CONVENTION.

ARRANGEMENTS have been perfected for a special vestibule train, composed of parlor, dining, and buffet cars, which will leave the Grand Central station, New York City, via. N. Y. C. & H. R. R. R., at 11:00 A. M., on Monday Febuary 22, (Washington's Birthday), and will connect with the Boston party at Albany. Seat checks for this train can be procured from C. O. Baker, Jr., master of transportation, room 505, 136 Liberty street, at the rate of two dollars each. Railroad tickets can be procured at the various ticket offices. It will, however, be necessary for the purchaser to request the ticket agent to furnish him with a certificate, which will entitle him to rebate fare on his return passage. These certificates are made absolutely non-transferable.

The following gentlemen have charge of transportation matters for their respective localities:

H. A. Cleverly........1018 Chestnut street, Philadelphia.
Fred W. Royce..1408 Pennsylvania avenue, Washington.
A. C. Shaw................620 Atlantic avenue, Boston.
John L. Martin..........146 Michigan avenue, Chicago.
Morris W. Mead..........................Pittsburgh, Pa.
S. D. Nesmith......... ...T.-H. Electric Co., Cleveland, O.
C. F. Hesser........Cincinnati Electric Light Co. Cin. O.
H. D. Stanley........................Bridgeport, Conn.
Prof. Henry T. Bovey..McGill University, Montreal, Can.
N. J. Hart..............................New Orleans, La.
James I. Ayer............322 Pine street, St. Louis, Mo.
Frederic Nicholls........................Toronto, Canada.
John I. Sabin........................San Francisco, Cal.
E. W. Rollins.....Denver Consol. Elec. Co., Denver, Col.

Reports of Companies.

STANDARD UNDERGROUND CABLE CO.

THE new board of directors of the Standard Underground Cable Co. met in the company's office January 28, 1892, for the purpose of organizing. Mr. Joseph W. Marsh was re-elected as vice president and general manger; Mr. Frank A. Rinehart as secretary and treasurer, and Mr. O. R. Ebel as auditor, and John N. Dalzell, Mark W. Watson and James H. Willock were chosen as the executive committee for the ensuing year.

The company declared a dividend of 1½ per cent., and made a strong showing of business despite the prolonged depression in trade.

A WESTINGHOUSE DIVIDEND.

C. A. TERRY, secretary of the Westinghouse Electric and Manufacturing Co., has announced that the Board of Directors has declared an interim dividend of 1 per cent. on the preferred stock of the company for the fractional part of the quarter ending Dec. 31, 1891, payable Feb. 1.

A POLICE SIGNAL SYSTEM FOR NEW YORK.

THE Board of Police Commissioners have invited proposals from the various electric fire-alarm and police-signal companies who wish to equip the police department.

The board want some system by which the attention of the patrolman on the beat can be attracted that he might know that he was wanted by the officer in charge of the station. This is just as essential as that the policeman should be able to call up the station house.

Among the companies represented are the Municipal Signal Company of Boston, the Metropolitan Duplex Fire and Police Signal Company, the Pierce & Jones Company, the Gamewell Company, the National Electric Manufacturing Company, United Fire Alarm and Police Signal Company, the Porter Teletype Company, the Electric Patrol Indicator Company, the Non-Interference Successive System, and the Herzog Teleseme Company.

DRY BATTERY PATENTS.

A SPECIAL circular in regard to dry battery patents has been issued by J. H. Bunnell & Co., who claim that serious infringement has been made of the Burnley patents. A hearing is now proceeding before Mr. H. C. Andrews, referee, appointed by the U. S. District Court, for evidence in a suit against the Manhattan Electric Supply Co., on account of alleged violation of the Burnley patents. The Manhattan Co. make what is known as the "Mesco" dry battery.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JANUARY 26, 1892.

Accumulators:—

Apparatus for Charging Secondary Batteries, C. O. Mailloux, 467,543. Filed April 24, 1891.
Provides means for charging a large number of batteries of the same or a different number of cells in series at the same time.

Apparatus for Charging Secondary Batteries, C. O. Mailloux, 467,544. Filed Apr. 24, 1891.
Similar to No. 467,543.

Charging Secondary Batteries, C. O. Mailloux, 467,545. Filed Apr. 24, 1891.
Preserves automatically the rate of flow of current through the battery without using cumbrous resistance coils or the like.

Apparatus for Charging Secondary Batteries, C. O. Mailloux, 467,546. Filed Apr. 24, 1891.
Similar to No. 467,545.

Apparatus for Charging Secondary Batteries, C. O. Mailloux, 467,547. Filed Apr. 24, 1891.
Similar to 467,545.

Secondary Battery, J. B. Entz & W. A. Phillips, 467,573. Filed Jan. 7, 1891.
Provides means of rendering the electrolytic action uniform.

Alarms and Signals:—

Electric Railway Signaling Apparatus, F. I. Myers, 467,581. Filed Mar. 16, 1891.
An improvement upon the existing "Sykes system" of semi-automatic signaling.

Electrical Signaling Apparatus, P. B. Delaney, 467,651. Filed Sept. 19, 1890.
An electrical alarm clock by means of which any number of alarms may be given within the compass of 24 hours.

Test-Circuit for Multiple Switchboards, C. E. Scribner, 467,901. Filed May 29, 1891.
An audible test signal of a character distinct from any sound which might be produced by any accidental cause.

Test Circuit for Multiple Switchboards, C. E. Scribner, 467,902. Filed May 29, 1891.
Provides means for ascertaining whether or no any line is in use at some other board.

Clocks:—

Electric Clock, F. A. Ellis, 467,748. Filed June 13, 1891.

Conductors, Conduits and Insulators:—

Composition of Matter for Insulating Purposes, D. H. Piffard, 467,520. Filed May 26, 1891.
A combination of rubber, resin and plaster of paris in the proper proportions.

Apparatus for Laying Underground Conduits for Electric Wires, H. B. Camp, 467,650. Filed Oct. 13, 1891.
A mandrel arranged to slide through an electric conduit as it is being laid for the purpose of cleaning.

Distribution:—

System of Electric Distribution, N. W. Perry, 467,897. Filed Apr. 13, 1891.
Has for its object to automatically disconnect conductors from a high tension main circuit when they become idle and to automatically reconnect them when called into use.

Dynamos and Motors:—

Alternating-Current Motor, L. Gutmann, 467,537. Filed Nov. 29, 1889.
Consists in producing relative motion of the armature and field-magnets by giving multiple poles to the armature, permanently forming local closed circuits in the armature by induction and increasing the induced currents in the closed circuits by an independent current.

Carbon Brush-holder, C. O. Mailloux, 467,542. Filed Mar. 18, 1891.

Heating:—

Electric Heater, L. Gutmann, 467,538. Filed Nov. 12, 1890.
An electric heater for cooking, etc.

Lamps and Appurtenances:—

Hanger for Electric Lamps, D. B. Matson, 467,511. Filed Nov. 24, 1890.
An arrangement whereby the lamp circuit is broken automatically when the lamp is lowered for trimming or repairs.

Incandescent Electric Lamp, E. P. Roberts, 467,623. Filed July 15, 1891.
Provides means for the protection of the wires passing through the socket piece and connecting with the electrodes.

Incandescent Electric Lamp, H. J. Gutman, 467,576. Filed April 10, 1891.
Has for its object to provide in an incandescent lamp the maximum area of shading and reflecting surface.

Electric Arc Lamp, J. A. Mosher, 467,610. Filed Jan. 24, 1891.
Relates to a novel method of feeding by reversing the movement of the magnet core.

Electric Arc Lamp, C. E. Scribner, 467,656. Filed July 3, 1888.
Contains two sets of carbons with clutch levers supported a short distance above the lifting lever and a cut-out carried by the lifting lever by means of which said lever may be raised a short distance without being obstructed by the weight of the clutch lever.

Incandescent Lamp Socket, P. Dunn, 467,716. Filed March 12, 1891.
A simple socket switch for incandescent lamps.

Measurement:—

Meter for Electric Translating Devices, H. H. Cutler, 467,669. Filed Jan. 2, 1889.
An arrangement by means of which the meter gives the highest indication when affected by the smallest current.

Metal-Working:—

Arc Metal-Working Apparatus, H. Howard, 467,752. Filed July 6, 1891.
Relates to improved methods of electric heating and welding.

Miscellaneous:—

Electric-Drill System, H. N. Marvin, 467,509. Filed Aug. 15, 1891.
A reciprocating drill operated without commutators.

Electric Drill System, H. N. Marvin, 467,510. Filed Aug. 21, 1891.

Has for its object to direct alternately into the two magnetizing coils rising and falling impulses of current.

Phonograph, J. H. White, 467,530. Filed June 4, 1891.

Automatic Electric Controller for Air Pumps, A. Bergmann, dec'd., B. Bergmann, administratrix, 467,551. Filed Sept. 18, 1890.

Relates to means for maintaining air or gas pressure in a receptacle connected with casks containing malt liquor, the air pump being driven by an electric motor provided with an automatic controlling device.

Rheostat, J. A. Mosher, 467,611. Filed Apr. 4, 1891.

Claim 1 follows:

A rheostat composed of heads, a cylinder held thereon, and strips surrounded by asbestos held to such heads and wrapped with braided wire.

Contact Board for Rheostats, S. H. Short, 467,613. Filed March 18, 1891.

A contact board for connecting in the resistances on an electric motor car.

Magnetic Separator, F. H. Richards, 467,645. Filed Oct 12, 1891.

A separator for paper pulp employing a trough having a depressed, transverse, magnetic floor section and a deflector extending into such trough over said section.

Electric Conductor Support, E. M. Boynton, 467,679. Filed March 19, 1891.

A bifurcated beam having blocks of insulating material inserted within it from which one or more conductors are suspended.

Door Opener, C. H. Grebenstein, 467,684. Filed June 26. 1891.

Adjustable Electrode for Dental Purposes, W. P. Horton, Jr., 467,738. Filed June 10, 1891.

Regulation of Electric Circuits, F. B. Rae. 467,773. Filed May 1, 1889.

Consists in an adjustable circuit-controlling and current-regulating switch so operated that the current admitted to the field magnet circuit will pass through the field magnet windings either wholly in series, partly in series, and partly in parallel, or wholly in parallel.

Electric Tell-Tale for Tanks, C. Reuter & G. Bollman, 467,774. Filed June 19, 1891.

Lineman's Wire Grip, C. A. Kent, 467,815. Filed May 22, 1891.

Magnetic Separator. F. H. Richards, 467,833. Filed Sept. 29, 1891.

A separator for removing particles of iron from paper pulp, etc.

Push Button, A. Lungen, 467,875. Filed Mar. 4, 1891.

Electric Wire Tapper, G. S. Neu, 467,891. Filed Sept. 17, 1891.

Railways and Appliances:—

Trolley Wheel for Electric Cars, L. A. Simons & G. R. Roof, 467,583. Filed Jan. 22, 1891.

Employs cutting edged corrugations on the surface of the wheel.

Station Indicator, R. B. Ayres, 467,678. Filed July 27, 1891,

Motor Mechanism for Street Cars, R. W. Thickins, 467,693. Filed Apr. 20, 1891.

Means of communicating the motion of a motor to the wheels of the street car.

Station Indicator, R. B. Ayres, 467,884. Filed Feb. 16, 1891.

Electric Railway, W. B. Hutchinson, 467,699. Filed Apr. 14, 1891.

Claim 1 follows:

In an electric railway a hollow carrier for the main conductor, said carrier having a longitudinal slot in one side and having its rear wall inclined downward to the slot.

Switches and Cut-Outs:—

Electric Switch, H. J. Haight, 467,504. Filed Dec. 24, 1890.

Has for its object to cut out one or more groups of local circuits without affecting the continuity of the line circuit.

Electric Switch, C. J. Klein, 467,540. Filed Apr. 6, 1891.

Employs a pair of tangential contact pieces one outside of the other, so arranged as to complete the circuit between themselves.

Telegraphs:—

Electric Indicating Instrument, H. J. Haight, 467,505. Filed Feb. 7, 1891.

An indicating instrument for use in dial telegraphy exhibiting meteorological data, stock quotations, etc.

NOTES ON THE CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

THE Electrical Exhibition at the Crystal Palace, like its predecessor of 1881, has been taken up most enthusiastically, and difficulty was experienced by the Palace authorities in finding sufficient space for the requirements of exhibitors. Messrs. Siemens Bros. show dynamos of their make in combination with Willans and Tangye engines, as used on P. & O. steamers.

The Brush Electrical Engineering Co. show a large number of Brush dynamos, and engines for driving them. Crompton & Co. show a Crompton dynamo combined with a Willans engine of 200 h. p. This machine is capable of running nearly 4,000 8 c. p. incandescent lamps, and is of the same pattern as the machines employed in the Kensington & Knightsbridge Co., Notting Hill E. L. Co., and Westminster E. L. Co. This company also shows Otto gas engine driving a smaller dynamo, which charges a large number of accumulators. Crompton mains are to be seen in section on this stand.

Messrs. Crossley Brothers, the original owners of the Otto patent, show a number of engines of their well-known type, driving various electrical machinery. The British Gas Engine Co. show their patent cycle engines. Messrs. J. F. Andrew & Co. show the Stockport gas engine. Dick, Kerr & Co. with the Griffin gas engine. Messrs. Day & Co., of Bath, a new form of gas engine, all driving dynamos of various makes.

In the nave a number of very important exhibits are to be seen, among which the Postmaster-General exhibits a complete set of apparatus, showing the instruments used from the introduction of the telegraph in 1887 to the present time.

The Edison Swan Co. show 10,000 incandescent lamps in one group making a most magnificent display. About 200 h. p. will be required to light these at one time.

The National Telephone Co. have established an exchange in connection with their London head-quarters, and rooms have been arranged where visitors may, by paying a small fee, hear the London opera transmitted by telephone.

The Consolidated Telephone Company, have two stands, one in the nave and one in the gallery, connected by telephone, and showing various kinds of instruments.

Messrs. Croggon & Co. show a model of a church with lightning conductors of the latest form. This church also has bells, rung by electricity from a keyboard below.

Messrs. Rashleigh, Phipps & Dawson have arranged their stand in the shape of an Egyptian mosque, introducing various designs as used by the ancient Assyrians. It is handsomely decorated and well lighted by electricity.

Crompton & Co., Limited, show various types of the Crompton dynamo, together with a large projector or search light, as supplied to the navy. This is erected on a conning tower as on board ship, the lights being thrown from one end of the Palace to the other. They also show the Crompton electric crane, which is made to travel, hoist, and slew at the same time. A new feature shown in connection with this exhibit is a new form of automatic lamp, which has only just been perfected. On this stand a complete testing station is shown, using Crompton Howell cells.

Messrs. Siemens Brothers show an important exhibit of large arc lights and poles, hand-regulating holophote, city posts, iron brackets of various shapes and sizes, samples of submarine cable, etc.

The Brush Electrical Engineering Company show various sizes of their well-known dynamos, arc lamps, Mordey alternators, and other machinery. They also show a full-sized electric car made at their Falcon Works.

Woodhouse & Rawson show a model of an electric launch built for the Thames, a patent winch, electro-hydraulic riveters, etc.; also different forms of electric lighting.

Messrs. Johnson & Phillips show buoys and other marine apparatus, together with dynamos and arc lamps as manufactured by them, an electric capstan for winding, and an electric pumping plant as used in collieries. This firm is making a speciality of electrical transmission. Among the other exhibitors in the nave may be mentioned Messrs. Osler & Co.; Messrs. Appleton, Burbey & Williamson; Messrs. Day & Co.

The galleries can be reached by means of Messrs. Waygood's electric passenger elevator driven by a Siemens single magnetic circuit motor.

Messrs. Rashleigh, Phipps & Dawson also show a dining-room fitted in Italian style to illustrate the adaptation of electric lighting. The lights are made to represent the solar system, the large light the sun, and the smaller lights the planets. Various wrought iron fittings represent fruits, such as the pomegranate, orange, lemon, etc. Various emblematic figures are used, among which is the figure of youth with a torch representing light. The decoration and furniture are by Messrs. Godfrey, Giles & Co., beautifully executed with a deep embossed frieze, etc. The conservatory is fitted up by D. Radcliffe, Ltd., showing rocky cliffs, dripping wells, etc., combined with electric light, and giving a very pleasing effect.

At night the Palace will be very powerfully illuminated, and a number of search lights are used. The catalogue has had added to it an interesting descriptive article at the commencement of each section, explaining the kind of machinery exhibited under that heading, and its uses. This is quite an innovation, and should make the book far more interesting than catalogues generally are.

KERITE.

MR. F. W. CUSHING who has just taken the general Western agency for "Kerite" insulated wires and cables, is too well known in electrical circles both East and West to require any lengthy introduction. His experience during the last five or six years in the construction of underground conduits, management of electric light companies and the general supply business eminently fits him for the line he has taken hold of and predicts an assured success for his new venture. No one in the electrical business is better adapted to increase the large business and retain the enviable reputation enjoyed by "Kerite" and in wishing him full measure of success we can say that Kerite is in the best of hands. We understand that the manufacturers of this wire have decided to place it in the prominent position which its merits deserve and have made recent improvements in its manufacture which render it second to none. The wire has been favorably known by the leading telegraph companies for the past 25 years and we have no doubt that before another year it will be just as well known and largely used by the electric lighting, power transmission and electric railway companies.

HAGERSTOWN, MD.—Notice is given that the firm of Benham & Schindel has been dissolved by mutual consent, Mr. A. D. Benham retiring. His interest has been purchased by Mr. Joseph E. Schindel. The style of the firm name hereafter will be Schindel & Schindel. The business will be carried on in all its branches as heretofore. With increased facilities the firm will be able to fill all orders for electrical wood supplies promptly and satisfactorily at lowest possible prices.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

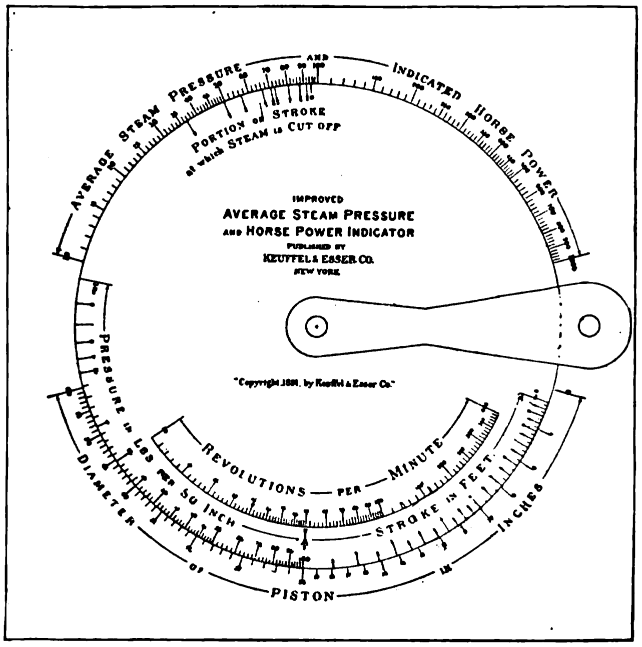
Both "alternating" and "continuous" advertisements are effective.

SPEEDY HORSE POWER CALCULATORS.

THE accompanying illustration shows a convenient means whereby the average pressure of steam in an engine cylinder may be instantly found. This average steam pressure and horse-power indicator consists of a square foundation plate with a circular disc about 8 inches in diameter, both being graduated in accordance with the factors of the formulæ whose solution they give.

In order to obtain the average pressure of steam with any ratio of cut-off, the zero of the cut-off scale on the disc is set to the initial pressure on the plate, then opposite any given cut-off will be found the average pressure in pounds per square inch for the whole stroke.

This indicator serves, however, a further and more important purpose. With it the horse-power of a steam engine can be found almost instantaneously, whatever the ratio of cut-off. By means of the radial edges of the movable arm shown on the right, the various factors of the formula


AVERAGE STEAM PRESSURE AND INDICATED HORSE POWER
PORTION of STROKE at which STEAM is CUT OFF
IMPROVED
AVERAGE STEAM PRESSURE
AND HORSE POWER INDICATOR
PUBLISHED BY
KEUFFEL & ESSER CO.
NEW YORK
"Copyright 1891, by Keuffel & Esser Co."
PRESSURE in LBS PER SQ INCH
REVOLUTIONS — PER — MINUTE
STROKE IN FEET
DIAMETER OF PISTON IN INCHES

A SPEEDY STEAM PRESSURE AND HORSE POWER CALCULATOR.

$$\frac{D^2 \times .7854 \times 2S \times R \times P}{33000} = \frac{D^2 \times S \times R \times P}{21008}$$

$= D^2 \times S \times R \times P \times .0000476$ are alternately brought into contact with each other, and the resulting horse-power is then found opposite the zero of the cut-off scale; the horse-power with the given cut-off being found, as already explained in the case of the average pressure of steam, on the top outer scale opposite the ratio of cut-off.

Another indicator, similarly constructed, gives the horse-power of a fall of water or of a turbine, when the height of the fall and the volume or discharge of water are known; or with the scales slightly modified, it gives the horse-power of a turbine or water wheel when the head of water, number of square inches of water vented, or diameter of nozzle are known, as well as the percentage of efficiency at which the turbine or water wheel is rated. It also shows at a glance the combinations of head and volume of water, etc., required to produce a given horse-power at a given rate of efficiency.

These instruments are manufactured by Messrs. Keuffel & Esser of this city.

MR. CHARLES A. TUCKER, president of the Tucker Electric Construction Co., has resigned, and disposed of his entire interest in the company.

WESTERN SPEED FOR WESTERN TRAVEL.

RUMOR says that an extraordinary fast mail train will shortly be run between New York and Chicago, making the entire trip in 17½ hours. This arrangement would lessen the time consumed between these points about 7½ hours. It is said that Third Vice-President H. Walter Webb of the New York Central and H. R. R. R. has informed Assistant Postmaster General Bell of his willingness to run a train over their lines as above. All Western mails would be greatly expedited by this arrangement, a difference of 12 hours being made to some points West of Chicago. By this arrangement mails leaving New York one day can be delivered in Chicago the next. The Central is evidently very much alive and on its mettle.

THE SCHOENBERG PNEUMATIC RESET FOR ELECTRIC ANNUNCIATORS.

THE simple and effective device for pneumatically resetting annunciator drops, shown in the accompanying illustrations, is due to the ingenuity of Mr. Ralph Schoenberg, of 129 East Sixty-second street. As will be seen, Fig. 1 shows the arrangement in normal position, in which the drops are free to fall, while Fig. 2 shows the act of resetting. But little explanation is required. The cross rods are all connected to a vertical bar, the lower end resting upon a small bellows, which is inflated by means of a bulb at the end of a tube of any reasonable length. The combined weight of bar and rods is sufficient to quickly contract this bellows when the pressure is relieved. This arrangement, aside from its convenience is claimed to increase the life of the annunciator, as the racking incident to the use of a mechanical reset is obviated.

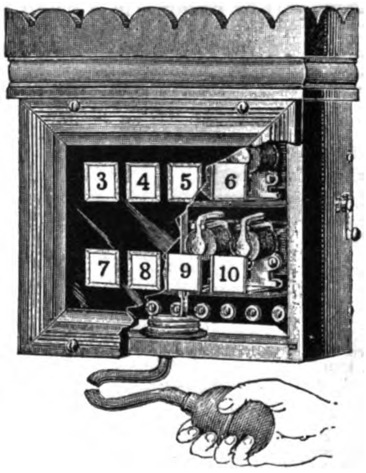


FIG. 1.—THE SCHOENBERG RESET.

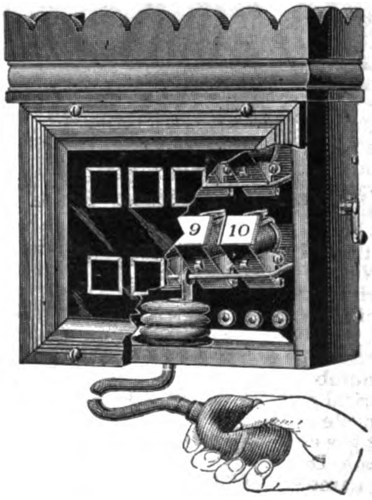


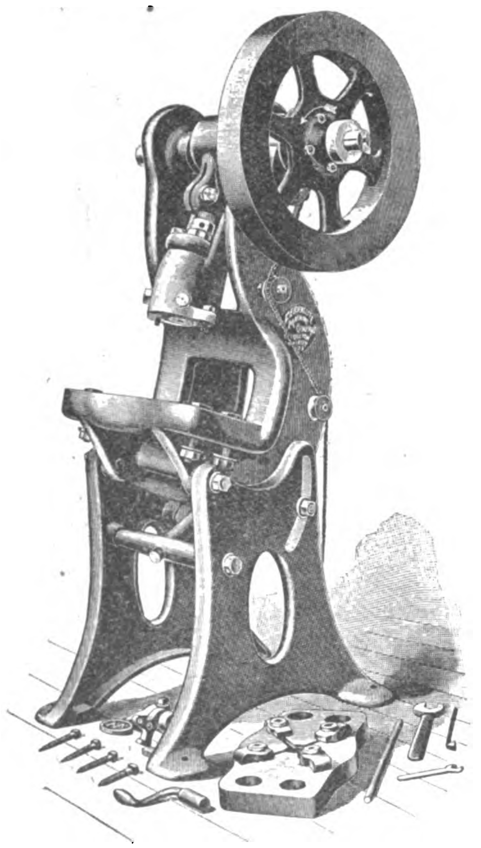
FIG. 2.—THE SCHOENBERG RESET.

This attachment can be readily applied to annunciators already in use, and is made in two sizes.

A NEW FERRACUTE CUTTING PRESS.

THE Ferracute Machine Co., of Bridgeton, N. J., have recently placed on the market the new cutting press represented in the accompanying engraving, which is well adapted for work in tin, sheet iron, copper, brass and other light metals. There are six sizes of these presses, the smallest weighing about 700 pounds, and the largest 8,600 pounds. These machines are fitted up with forged steel shafts, carefully scraped working surfaces, hardened steel clutch, case hardened bolts and nuts, forged wrenches, etc.

Among the features to which the manufacturers call special attention is an arrangement of parts by which the centre of the die rises but little higher in the inclined position than in the upright, and a self-supporting device by which any inclination may be quickly obtained by slightly loosening the leg nuts and revolving the crank of the elevating screw. Reference is also made to the great height from the bed up to the ram, so that all sorts of high dies may be used when the ram is adjustable. The machines have long ram adjustment with a powerful grip for locking the pitman stem by a slight motion of the wrench upon a single bolt. A clutch of simple construction, working in a solid enlargement of the shaft with no nuts or screws to become loose, is also a feature of the machine. The construction is such that the whole device may be taken apart by pushing in a small pin. Another feature is a clutch tripping arrangement adjustable through a large arc about the axis of the shaft, and which is graduated to trip as early or late as desired. This adapts the press not only to a great variety of speeds, but to a great variation of loads upon the shaft as well as to different degrees of tightness in gib and other joints. A spring brake is placed under the shaft at the end where the fly-wheel would naturally wear down the journal boxes the most, and therefore compensates for its weight. A treadle-lock allows the treadle to be fastened down for continuous running, or up for the purpose of guarding against accidental starting.



NEW FERRACUTE CUTTING PRESS.

The machine is substantially built in all its parts, and is provided with four sliding steel clamps which grip die-plates of any size or shape within their capacity, and are firmly secured to the press by four bolster bolts shown in the bed.

PELTON WATER-WHEELS.

THE Pelton Water-Wheel Co. report a season of great activity both in their San Francisco and New York works, orders for 492 wheels having been filled during the past year, of capacities varying from 10 up to 1,200 h. p., an increase in number of nearly 100 over that of the previous year. The majority of these wheels have been sent to the mining districts of the Great West, although large numbers have gone to Mexico, China, Japan, Australia and many other foreign countries.

The extraordinary success that has attended the introduction of the Pelton wheel in all parts of the world indicates that it is fully meeting the varied requirements of such service, as well as the fact that there is a better appreciation of the value of water powers for all industrial enterprises. Any information relating to this system can be obtained by addressing the Pelton Water-Wheel Co., 143 Liberty street, New York City, or 121-123 Main street, San Francisco, Cal.

PASS & SEYMOUR SPECIALTIES.

THE accompanying illustrations, Figs. 1 and 2, show the latest novelty in ceiling rosettes introduced by Messrs. Pass & Seymour, of Syracuse, N. Y. As will be seen, the fuse is always visible, and can be removed, when blown, with the utmost ease and readiness. To do this the screw A is loosened two or three turns and the fuse inserted through the slot C and the screw A tightened.

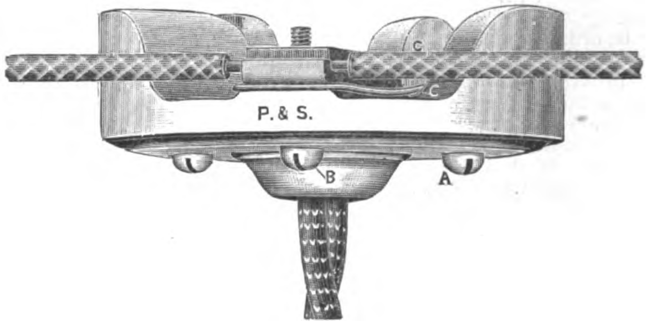


FIG. 1.

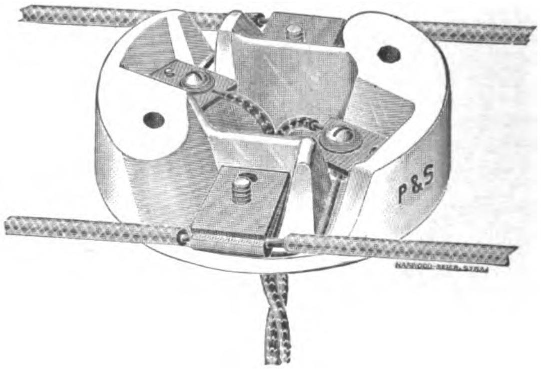


FIG. 2.

The screw B is then loosened two or three turns, the fuse wire is drawn under the wire clamp, and the screw B tightened. The wiring tube, Fig. 3, is particularly adapted to concealed work. The body of the tube is made an easy fit for the hole bored through the floor joists. On one end are several slight projections placed at irregular intervals so that when the tube is driven through the hole it cannot be withdrawn except in one position. The other end has an enlarged head, so that the tubes can not be displaced when the wire is drawn through. They are made of the exceedingly strong "Syracuse" china, and are practically indestructible.

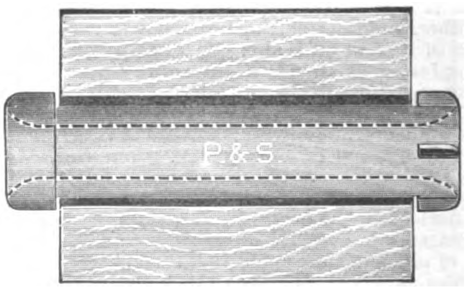
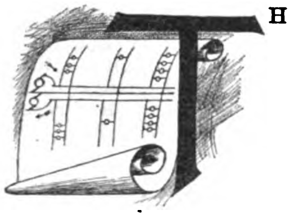
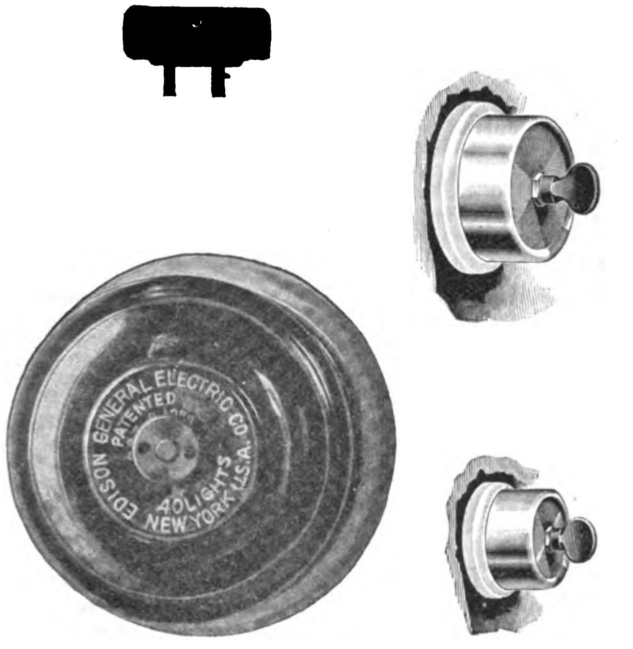


FIG. 3.

NEW EDISON SWITCHES.



THE ratchet switches made by the Edison Company are known and used wherever electricity is used for light or power. Quite recently, however, improvements have been made in these and entirely new styles have been devised to meet the ever-growing demand for small and effective ratchet wall switches, shown in the accompanying illustrations. These are of 5 and 10 amperes capacity, single pole, with bases and ratchets of hard vitreous porcelain, manufactured by the Edison Company at Schenectady. The ratchet is of peculiar construction, its sides being of unequal length, and when on the shorter sides of the ratchet are presented to the contact brushes These sides are rounded and the brushes specially curved, so that when the contact is made, the brushes and contact sides of the ratchet fit with precision. The ratchet itself is made of the best insulating material known. These switches are rendered instantaneous by an improvement introduced in the ratchet face. The cover is of metal which can be finished in any color, and is therefore peculiarly suitable for use in houses and buildings where artistic interior decorations are desired. The ratchet is removable and can be discarded in case of accident and another substituted, without destroying the entire switch.



New Edison Switches.

The Edison General Electric Company have also adapted their ratchet switches to the special use of hospitals, asylums, steamships and elsewhere, furnished with a small collar fitting outside the cover and firmly screwed down upon the ratchet pin, which cannot be turned except by means of the key in the possession of a competent person. These switches will doubtless be in great demand and have already met with gratifying success.

The Schenectady Works of the company have been compelled to enlarge considerably the department in which switches are manufactured, and the facilities now possessed for turning them out are perhaps greater than those possessed by any other manufacturers of similar appliances in the world.

THE HIMMER & ANDERSON "PERFECTED" DRY BATTERY.

The many advantages which a battery employing no liquid possesses over those in which a solution is used, has of late served to bring into prominence the dry battery. Cells of this type evidently can be set up exactly as they are received from the manufacturers, require no attention, such as the addition of water due to evaporation, and can, besides, be used in situations where a liquid battery would be out of the question, as, for instance, on cars, steamboats, yachts, etc.

The Himmer & Anderson Dry Battery Co., of 123 Chambers street, this city, have recently brought out their "perfected" dry battery which is in more than one respect a remarkable product. Tests made in our presence showed the cell to have an E. M. F. of nearly 1.8 volt, and on short circuit gave no less than 11 amperes; it held its E. M. F. and current for an appreciable time, and its recovery after a short rest was complete; the cell tested was circular, measuring 3 inches in diameter and 7½ inches high. These cells are made in a number of sizes, and arrangements are complete for turning them out in large quantities.

Mr. A. E. Kornfeld, formerly in the business department of *The Electrical World*, has assumed the business management of the Himmer & Anderson Dry Battery Co., and his energy will no doubt result in securing a large share of business for the company. He is well acquainted with the trade, and was never one to let grass grow under his feet.

NEW YORK NOTES.

A. B. & C.—The corporation of Alexander, Barney & Chapin, 20 Cortlandt street, has just voted an increase of their capital stock from $100,000 to $150,000, the new issue of $50,000 to be preferred stock bearing interest at 8 per cent. per annum. A statement of the affairs of the concern was submitted at the stockholders' meeting, showing a wonderful increase in the business, which could be much more enlarged by the addition of new capital. Quite a good many thousand dollars of the preferred stock are already subscribed for, and the balance is offered to the public.

Mr. W. J. Hammer, the electrical engineer and expert, of Temple Court, has gone abroad for a few months. He has been specially commissioned to place a number of very interesting American specialties in the electrical exhibition at the Crystal Palace. He will also visit various countries on the Continent before his return. Any one desiring to communicate with him may do so through his New York office.

Col. W. E. Sheldon, treasurer Fitchburg Engine Co., spent last week in the city. Col. Sheldon has been on an extended trip through the South, where he has closed up some handsome contracts for his company. During his stay here last week he sold an 80 h. p. engine to Healy & Co., the carriage manufacturers, located at 51st street and Broadway, this city.

Mr. F. C. Timpson, late of the Empire City Electric Co., has now opened an office in this city at 18 Cortlandt street, as the representative of the Electric Engineering & Supply Co. of Syracuse, N. Y. He has Room 511 in the Telephone Building and will handle all the electric light and railway supplies of the pushing manufacturers above named.

Mr. W. R. Mason, general manager of the Electric Merchandise Company, Chicago, was a visitor in New York last week. Mr. Mason has volumes to speak in praise of the favorite specialty handled by his company. This refers to the Burton electric heater.

WESTERN NOTES.

The Electric Appliance Company report that business prospects are very bright and state that although January had been a very quiet month in the electrical supply business all over the country they did a largely increased business during the month. The C. E. M. goods seem to have found general favor with the trade, and the Electric Appliance Company are unable to keep up with their orders for sockets and cut-outs of the Consolidated Company's manufacture. They are also showing an elegant line of jack knife switches in single pole, double pole, three pole and throw over, of which they carry a large stock ready for immediate shipment.

St. Louis Electrical Supply Co.—The recently elected directors of the St. Louis Electrical Supply Co. met last week for the purpose of organization for the current year. E. Ruebel was elected president and treasurer, William N. Matthew, vice-president and Joseph Hummell, secretary. This is the company of which the late W. L. Scott was president. Mr. Matthews, who is a son of Leonard Matthews, Esq., and who for many years has been connected with the Collins Bros. Drug Company, it is understood, has purchased the interest formerly held by Mr. Scott.

The Electrical Supply Co., of Chicago, are having an unusual demand for Habirshaw rubber covered wire for which they are the Western agents. A single order called for over $15,000 worth to be used in wiring one of the large office buildings in that city. The Sunbeam lamp is another one of their leading specialties and is rapidly growing in popular favor. The Electrical Supply Co. introduced this lamp by small trial orders, and are very much encouraged to get from these same purchasers duplicate orders in three to five thousand lots.

Great Western Electric Supply Co.—The directors of the Great Western Electric Supply Co., at the December meeting declared a dividend of two per cent. amounting to $7,000, on the £350,000 of preferred stock of the company. This was paid on January 10. It is worthy of note that the preferred stock of this company has added nearly one hundred names to the list of its holders during the last ninety days.

POND ENGINEERING CO.—The Electric Light Company, Albuquerque, N. M., have telegraphed an order to the Pond Engineering Company, St. Louis, for a 100 h. p. Armington & Sims engine, this being their third order within one year. The Equitable Gas Light & Fuel Co., of Chicago, Ill., have contracted with the Chicago office of the Pond Engineering Co. for an Armington & Sims engine to drive a large exhaust fan. This plant is already in use by two other gas companies in Chicago, and is proving very popular in gas plants.

THE ELECTRIC APPLIANCE COMPANY report that although it is very early in the season they are nevertheless having a demand for the swinging ball lightning arrester, and requests for information in regard to it that promise a big business when the season gets further advanced. The swinging ball lightning arrester has had a test of three years' practical service in stations in nearly every part of the United States and has a wonderful reputation, as it has never been charged with a single failure to do its work.

THE "BANNER" WEATHER PROOF WIRES handled by the Central Electric Company, are noted for the firmness and waterproof qualities of the insulation. The manner in which the braid is woven on the copper, gives it particularly firm and lasting qualities which braided wire rarely possesses. Nothing but the best grades of cotton and compound are used in the process of insulating, and these wires are particularly adapted for use among trees, where the circuits are subjected to severe abrasion.

THE MASONIC TEMPLE, CHICAGO, to be lighted by the Thomson-Houston Co., will have about 8,000 lights in generating capacity, and about 7,000 lights are being wired for. Simplex wire is being used for the purpose, requiring 6 tons of mains and feeders, 50 miles of No. 14 and 10 miles of No. 16. The building is 21 stories high, or 302 feet from street to roof. The Western Isolated Department of the Thomson-Houston Co. is also furnishing the lamps and sockets—at regular prices.

THE ERNEST L. CLARK CO. report an exceedingly large volume of business in poles, etc., for the past month and very encouraging prospects. This company is making a specialty of octagonal Norway pine poles which they are manufacturing in large quantities.

THE MOSHER ARC LAMP CO. recently shipped a number of their arc lamps for incandescent circuits to China, some of which were installed in a Chinese theatre and proved a drawing card among the Mongolians, large numbers of whom went to see the new moon.

THE CENTRAL ELECTRIC COMPANY report having on hand a large stock of the supplies manufactured by the Interior Conduit & Insulation Company, of New York, and are consequently enabled to fill all orders for these materials with exceeding promptness.

MR. F. S. TERRY, the general manager of the Electrical Supply Co., Chicago, has been seriously ill for two weeks. It was at first feared that it might result in pneumonia, but he is now able to be up and about.

MR. H. M. UNDERWOOD, who for some time past has been representing the Knapp Electrical Works and Safety Insulated Wire Co., has severed his connections. Mr. Underwood is widely known amongst electrical people both East and West.

MR. GEO. T. HEWES, well known amongst the electrical fraternity in the West, is now general manager of the Faribault Consolidated Gas & Electric Co., Faribault, Minnesota.

J. H. SIEGRIST, JR., & CO., St. Louis, are now placing an 80 h. p. "Ideal" self-lubricating engine in the new plant of the Jefferson City (Mo.) Gas and Electric Light Co.

MR. LAFAYETTE COLE, of Holmes, Booth & Haydens, was a visitor to Chicago last week on his way East. He reports a highly prosperous trade, especially in the far West.

GUSTAVE MONRATH, of 1302 Auditorium Tower, is superintending the plants which are now being installed at Marseilles, Ill., all of which are run by water-power.

THE ELECTRIC CO. have taken the general Western agency for the Pennsylvania lamp. They are already receiving a large number of orders and inquiries.

MR. GEORGE CUTTER is supplying the new plant at Elmhurst, Ill., with his well-known street hoods fitted to a bracket arm of novel design.

THE GARDNER-MORGAN MINING MACHINE CO. have their mining machine about ready for the market.

NEW YORK NOTES.

MR. I. P. FRINK has now on hand a large number of orders for reflectors and reflecting chandeliers in which electric lamps are used, covering all classes of public buildings, and well distributed over the States; among them the following prominent churches: Protestant Dutch Church, New York City; Christ Church, Jersey City, N. J.: First Presbyterian Church, Fostoria, O.; M. E. Church, Venturo, Cal.; Catholic Church, Owatonna, Minn.; Fourth Presbyterian Church, Pittsburgh, Pa.; M. E. Church, Plainfield, N. J.

THE INTERIOR CONDUIT & INSULATION COMPANY are making large shipments of their new Johnson switches to their agents, and the principal central stations in the United States. They are already some thirty days behind time in their orders, one illuminating company alone having ordered 1,100 of their well-known switches in two days. The company has in preparation a handsome illustrated catalogue setting forth the good qualities of this switch. This catalogue will be issued together with a revised edition of their well-known No. 4 catalogue, in the course of the next ten days or two weeks.

A. & F. BROWN & CO.—Purchasers of pulleys, hangers and shafting are reminded that Messrs. A. & F. Brown & Company, probably the largest manufacturers of these goods in the United States, will remove their office and salesrooms from 44 Park Place to 17 Dey street, New York, the quarters formerly occupied by the Edison Machine Works, in the same line.

THE ELECTRIC CONSTRUCTION AND SUPPLY CO. are introducing something entirely new in an arc lamp for use in the process of photo-engraving. The lamp and necessary apparatus are exceedingly compact and of course portable. They are also exhibiting in their offices this week a very handsome projector, one that is perfectly automatic.

NEW YORK ELECTRICAL CONTROL.—Various schemes on this subject are before the Legislature. It is proposed to extend the term of the New York City Board, while another bill provides for a State Board.

W. H. MCKINLOCK, president of the Central Electric Co., Chicago, has been a New York visitor for several days. He intends spending some time in the South before returning to the World's Fair city.

Mr. W. J. Cooke, vice-president of the McGuire Manufacturing Co., Chicago, makers of the McGuire truck for electric cars, was a New York visitor last week and called at this office during his visit.

GERRYCIDE.—The New York Legislature has modified the electrical execution law, so as to permit of a certain number of reporters being present at the performances.

THE PREMIER ELECTRIC COMPANY have received among others two handsome orders this week for their new fan motors, aggregating 400 motors.

MR. C. A. BENTON, manager of the railway department of the Detroit Electrical Works, was in the city last week.

D. B. DEAN, general salesman for the Electric Merchandise Co., Chicago, is in New York.

NEW ENGLAND NOTES.

THE MASSACHUSETTS WIRE COMPANY, of Malden, Mass., are installing a 400-light incandescent plant in their factory, which will materially assist them in the manufacture of their wires. The Massachusetts Company are large manufacturers of all grades and sizes of magnet wire, and have achieved quite a favorable reputation for the uniform quality of their goods.

THE MASSACHUSETTS ELECTRICAL ENGINEERING COMPANY, of Boston, through their testing department, have issued a neat little calendar and paper weight combined, consisting of one of their spools of tested fuse wire, tastefully finished, and having a small calendar attached. Any person can be supplied by applying to them at 4 Post Office Square, Boston.

THE JENNEY STAR ELECTRIC COMPANY, whose factory is at New Bedford, Mass., has moved its Boston office to 196 Summer street. Mr. A. W. Rounds, the treasurer of the company, reports that they are making good progress at the factory, and are now busy making several sizes of the motors, and that the general outlook for business was very good.

MR. IRA W. HENRY, constructing electrician for the Bishop Gutta Percha Company of New York, was in the city this week, and favored this office with a call. Mr. Henry reports that the Bishop wire is now on the list of wires accepted by the Boston Board of Fire Underwriters.

THE NEW HAVEN INSULATED WIRE COMPANY, of New Haven, Conn., reports business as very good, and their factory is taxed to its uttermost running day and night to fill orders, which will probably keep them busy for the next two months.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

Vol. XIII. FEBRUARY 17, 1892. No. 198.

AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—V.

BY

Mary A. Henry

FARADAY and Henry have asked the same question of Nature, and in the same way, and Nature has replied to each by the tremble of a needle and has confirmed her assertion by that beautiful thing, a spark. The great discovery of magneto-electricity is made. They were not conscious rivals, these two great men. Widely separated, each was simply intent upon finding out what Nature had to teach. If one had failed to make this gift to the world the other would have done so. We desire to make no ungracious comparison between them, yet it is but just to consider the position which each held in reference to the discovery. As Mont Blanc raises its snowy peak unchallenged above mountains of lesser but still great height, so Tyndall regards this achievement. Let us look at the two men in their relation to it, as they seem to stand before us, side by side.

1. As to advantage of circumstance. To scale the dizzy height, the advantage is with the mountaineer best equipped in experience, training and tools. If such advantage may be claimed in considering this discovery, let us look back and see again the different circumstances of the two men. Faraday, with nine years of advantage in age, has been at work in the Royal Institution of Great Britain for eighteen years, surrounded by every facility for study; with ample time at his command and under the instruction of one of the most eminent men of the age. Henry, in what was then a frontier town of a new country, with no other aid than his own earnest purpose, has had to snatch his days of investigation out of busy years filled with other matters; his only apparatus rude tools made by his own hands.

2. Faraday has been at work upon the subject since 1824; has tried it again and again "without result," although the phenomenon, unperceived by him, has been actually produced under his hands. Henry succeeds in his first attempt. Faraday has been, as it were, climbing for years the ascent, while Henry, at one spring, is at the top. Is this due only to the aid Henry's magnet has given both men? We cannot but feel, that under any circumstances, Henry's quick experimental instinct would not have been long in catching the moment when the gnome was at work. Look at the two men when the phenomenon is produced in the same way. Henry sees immediately that Nature's answer to his question is in the affirmative, and recognizes as immediately the proviso, namely: change or motion in the magnet. Faraday is not sure his fish is "not a weed;" tries again, to fail, as he could not have failed if he had understood what he saw; and not until he has made the experiment in another and entirely different way, is he sure of the phenomenon and recognizes its principle.

3. As to the means of the discovery, Henry's magnet. He had sent it over to Faraday in *Silliman's Journal*. He had made it for himself, out of his own brain and with his own hands. In making it he had made the stepping-stone for both; had made it easy for Nature to answer the question. We might almost say the magnet made the discovery. [This does not conflict with our assertion, that Faraday, using the magnet in the form of a ring, did not really make with it the discovery, but with a permanent magnet later. The ring showed him the phenomenon, and if he did not fully recognize this, led to his subsequent perception of it.]

4. As to priority: And now we come to the chief object of our story. It has been hitherto supposed that Faraday could claim this, but is it so? Certainly, on the score of publication. His first series of brilliant experiments was given to the world in November, 1831, while Henry's paper did not appear until July, 1832; but the world, advancing rapidly in every way, will soon no longer ask who was the first to *publish* but who was the first to *do*. Which of these men was the first actually to make this discovery?

Let us attend first to Henry's spoken statements. Sympathy is the gold of the heart, by means of which mind may win from mind its burden or its treasure. Quick to feel sympathetic interest in the concern of others, a like interest in his own affairs was a strong need in Henry's nature. Often by the fireside in his home he told to his wife and daughters the story of this great early disappointment; the story in facts as we have given it. How he made the discovery of the extra current five years before Faraday. How the discovery of magneto-electricity followed in 1830. How eager he was to pursue it, and how baffled by lack of time and materials. How he wished to amplify his results before he gave them to the world, and how he had commenced his great preparations for this purpose, and then, one day, in the library of the Academy, seizing eagerly upon a newly-arrived periodical, how he suddenly came upon the notice which told him that although he had made the discovery so long before any one else, Faraday must claim it. He might hurry his results into print but Faraday was there before him. "He who publishes first claims the discovery" was a code strictly held by Henry, and so he laid down all claim to the discovery, and in the years which followed in Princeton always attributed it in his lectures to Faraday. An old friend (Rev. Theodore L. Cuyler, D. D.), one of Henry's earliest pupils in Princeton, said recently to one of his daughters, "Your father often spoke to me of his disappointment about that discovery. 'I ought to have published earlier,' he used to say. 'I ought to have published but I had so little time. It was so hard to get things done. I desired to get out my results in good form and how could I know that another on the other side of the Atlantic was busy with the same thing?'"

Let us now study the evidence which lies under our eyes, in the published statements, and the one or two letters we have collected in this article, and see whether they corroborate our story. Bence Jones says that Faraday commenced experimenting the 29th of August, 1831, and that "the first experiment detailed in his note-book records the discovery." The experiment with the ring was made that day or the next, but the discovery, as we have shown, was not really made until the 24th of September, when he first recognized positively the distinct conversion of magnetism into electricity. However this may be, *the 29th of August is the utmost limit for earliness to be claimed for Faraday.*

And now let us look at Henry's paper. We have given it entire, so that the reader may judge what it seems to say. It is published in July, 1832, but in its beginning it refers to last August, *that is August,* 1831, *the very August when Faraday is making his ring.* Henry says experiments were interrupted then, not to be resumed until "*the last few weeks,*" which we find from the latter part of the paper means "*the last two weeks* in June" (that is of 1832). A letter to Professor Silliman gives us the cause of this interruption, namely, that the room used by Henry was required for the opening of the Academy, and from another source we learn that the Academy opened the first of September. So this is the first thing we learn, that Henry is busy with the subject at the same time that Faraday is, in August, 1831, and that between that time and the last two weeks in June, there is an interval in which there are no experiments.

The second thing we learn from the paper is that in this interval, "in the meantime," Henry says, comes a brief notice of Faraday's results dated April, 1832, and which Henry gives in the paper.

Now look again into the paper. It consists of a description of two series of experiments, *the one made before, the other after, seeing the notice of Farday's result, dated April,* 1832. In the first series we find the great experiment. *If made before April,* 1832, *then before the close of August,* 1831, *the time when experiments stopped,* and into the very last of those August days must we bring the experiment in order to give Faraday priority, the utmost limit of earliness for Faraday being the 29th of August.

If our claim is just, that the discovery was not fully made by Faraday until the 24th of September, more than three weeks later than the last of August, the limit of lateness for Henry. Our point is proved here, but we desire to give every allowance to Faraday, so let us consider the ring experiment, the very earliest possible limit for Faraday.

This experiment was made the 29th and 30th of August, so there is but one day left, as we have said, into which we must squeeze Henry's experiment to give Faraday priority. It is not likely that Henry was at work on that last day; he had to give up his room to be cleaned, to remove his apparatus. But if at work, what is he doing? Not making this discovery—it has been already made. We are not left to conjecture; he tells us in his paper with what he is busy in those August days, "*making a great magnet and other preparations for a series of experiments with it on a large scale, in reference to the production of electricity by magnetism.*" We see exactly from the letters we have given, what he is doing when the cruel interruption comes; insulating with his own hands "*a mile of wire;*" "*bending a bar of iron weighing* 101 *lbs. into a horseshoe;*" and almost pathetic is the glimpse of the unfinished magnet, with all the labor it has entailed, in Henry's room in November, through the letter to Professor Cleaveland. Uncompleted is it still, when the following June comes and the experiments are resumed on a smaller scale. Henry does not say in his paper when in August the magnet was commenced, but considerable time must have been consumed in its construction before the 29th came. He had to stand over the workmen while they forged that bar weighing 101 lbs. He says in another letter to Professor Cleveland: "I can get nothing done in the philosophical line in Albany except I stand over the workmen myself, or, which is most often the case, do the work myself." The insulating and winding of that reel of wire, a mile in length, alone represents an enormous amount of time to say nothing of the winding of the magnet. Of the labor entailed by the latter, we may have some idea from what he says of the magnet prepared for Professor Cleaveland, in that letter of May 8, 1832. "The winding of the wire was done with great care and and under my constant inspection * * * * * the process was a very tedious one and occupied myself and two other persons every evening for two weeks." On this particular magnet was wound 1,000 feet of wire, and Henry's unfinished one was larger, while "the reel of wire a mile long" was as carefully prepared. Henry must have been at work from early in the month, on these preparations for his extensive series of experiments when that memorable 29th of August came, and so we drive back the initial experiment *made before these preparations were begun,* to pursue the subject on a large scale. But it matters not for our present purpose whether this experiment was made days, weeks or months before that 29th of August, since it was before, to give Henry priority.

And so again is our point proved, since on the only day into which we must force Henry's experiment in order to give Faraday priority, Henry is distinctly busy *about something else.*

Does the paper tell us anything else to throw light upon the date of the discovery? The magnet upon which it was made tells us something. Henry tells us in his paper that the galvanic magnet used was the one described in *Silliman's Journal* vol. xix.; the one he had made to sustain seven hundred pounds. The date of the paper in which it is described is January 1, 1831, and the magnet was made in 1830. Thus is fixed for us the limit of earliness for Henry, that is, 1830, but there is something more in the use of this magnet. It suggests the probability that in this year 1830 the experiment we are in search of was made, because in January, 1831, was constructed the great magnet for New Haven, which remained in Henry's laboratory until spring came to break up the ice in the Hudson and allow it to be taken to its destination. With this more powerful, more complete magnet, in his possession, it is natural to suppose Henry would use this to ask the important question, rather than the earlier and inferior one, unless the experiment had been made before the construction of the larger one.

ISOLATED ELECTRIC LIGHTING WITH LOW-TENSION ALTERNATORS.

BY

William Smith Horry

For the last thirteen years there has been little improvement in the methods of isolated electric lighting. The direct current dynamo has undergone some changes. It was very soon recognized that the series wound machine was unsuited to incandescent lamps in consequence of its want of regulating qualities. The shunt machine was then brought out and partially remedied this want and very soon after the two systems were compounded. It then took several years to finally perfect this principle and to achieve the excellent regulation we have to-day in this class of machines. Since then improvements in detail have been made and the insulation of the whole system has been improved. The armatures of dynamos are no longer driven at some thousands of revolutions a minute and the magnetic circuit has been greatly shortened and augmented in area.

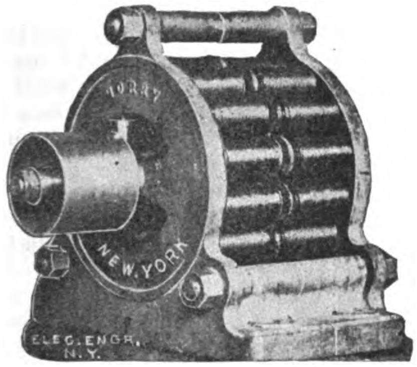
The great nuisance of the commutator has not yet been lessened in incandescent light dynamos except in so far as the speed has been reduced and it still remains an evil; the more especially as these isolated plants are mostly under the care of an engineer who rarely acquires the knack of taking care of it. The lamps themselves are infinitely more durable than they were.

Arc lamps two in series and with a resistance inserted, are now used with success and with a certain degree of economy, so that the general utility of the two wire system has been thereby extended. The principle however is greatly deficient in adjustability; both gas and oil surpass it in this one quality. When this is attained the direct current system will be as thorough as lighting can ever be that depends upon revolving commutators and moving machinery for its action.

It is quite usual to install two distinct types of machine, one for arc series lighting and another to work incandescent lamps. This is done in most installations of any considerable size. A double system of wiring is used for the different systems and the expense is great. Then there is an element of danger attending the series machines and moreover the lighting is still incomplete as it still lacks adjustability.

It is quite as important that the incandescent lamps shall be under control as that they shall be sufficiently powerful and economical. The invariable result is that with both systems of electric lighting in use in a building and with wires all over the place, gas has still to be used where adjustable lights are required. Therefore it cannot be said that isolated electric light plants, as at present installed, are perfectly successful unless helped out with gas and with two sets of mains.

It is proposed to overcome these objections by using the low tension alternator, so that one set of mains only will be needed, to answer all requirements for both arc and incandescent lamps; the latter are perfectly under control just as gas is, and the whole system is practical and economical.



HORRY LOW TENSION ALTERNATOR.

The alternating current system has fallen into disuse in isolated lighting. The main advantage it possessed was the absence of the commutator which made the manipulation of large currents very easy. Until recently there was no great demand for large currents; the extra exciting machine was therefore considered a greater evil than the commutator of the direct current dynamo. Unlike this machine, however, the alternator has been considerably improved and simplified during the last few years, so that the objections that were raised to it several years ago no longer apply. The alternator in one form or another is fast monopolizing every field where it has once gained entrance, and gives evidence of greatly extended usefulness in the near future.

The reasons for this are not far to seek. The alternating current is the natural form of electricity mechanically generated. It is unfortunate that the period of the alternations usually employed in this country for general distribution is too high to use motors profitably, but even this trouble may be overcome when we understand the laws of magnetism better than we do now. It would seem that the natural dynamic current is the one that must eventually be adopted for all dynamic purposes, rather than the peculiar current—mechanically speaking—that we obtain by the intricate and troublesome thing called the commutator.

The alternator in its most simple and latest form is now proposed instead of the direct current dynamo for isolated lighting, and possesses certain unmistakable advantages. It has neither commutator nor collectors; all the electrical parts may be fixed and the iron pole pieces alone revolved. So far as I have used this machine, however, its self regulating qualities leave something to be desired. However the difficulties arising from self-induction are not great, and can easily be met by careful designing. Another machine that is better in this way is one with a copper disc armature, similar to that shown in the accompanying illustration; here the self regulation is almost perfect, so that at all loads the electromotive force remains substantially the same, with the speed constant. The armature of this machine will stand an enormous current without injury, being open to the air on all four sides. It will run continuously with a current density of considerably over 4,000 amperes to the square inch and will transmit double that for some time without serious heating. These qualities and the great simplicity of the machine single it out as best suited for isolated lighting.

It is proposed to use this alternator wound for, say, 50 volts potential, and directly connected to the mains of the building to be lighted. Should there be grounds or large spaces to be illuminated, single arc lamps can be used in parallel where necessary, while incandescent lamps can be installed in the ordinary way. But for some purposes, especially on all the upper floors, adjustable lights are a necessity. The lamps are here inserted in the Ries regulating socket and the system then possesses all the adjustability of gas lighting.

The writer was prepared months ago to support the argument that there was considerable economy to be gained by the use of these sockets if the lamps were systematically turned down, as gas commonly is, when all their light was not required. But he was never opposed in this opinion by any evidence to the contrary, so he affirms it again here without fear of successful contradiction, and gives in detail the reason for this economy.

An incandescent lamp can be turned down by the Ries socket with very nearly the same result in economy as is gained in a gas light when turned down in the same way. Take, for instance, a fifty volt 16 c. p. lamp. This gives a sunset red glow with 12.5 volts and with somewhat less than a quarter of an ampere of current. That is to say, that the energy consumed by lamp and socket together only amounts to 3.125 watts. Sixteen lamps turned down only consume the energy of one lamp burning full on. Now a gas burner taking only a sixteenth part of five feet is very small indeed and it is carrying economy to a miserly stage to turn it down so low. Of course the incandescent lamp is a very uneconomical light giving device unless worked at its full brilliancy but a red glow can be very cheaply produced, and this is of great convenience as it indicates the position of the lamp in the dark, and also the position of its regulating mechanism. Gas also has its critical pressure and burns much less efficiently as a light giving agent when turned down. The very careful trials the writer has made with the Ries socket and the incandescent lamp satisfy him that in this respect it is very nearly on a par with water gas. Added to the economy of current, however, the lamps themselves last an infinitely longer time if their full duty be but little required. The economy of power will then be conceded just as the economy of gas is effected by its systematic adjustment as is universally practised in our stores and homes.

In carrying out this system the period of the alternator is low enough to prevent undue heating of the choking coils arising from hysteresis or eddy currents in the iron, and high enough to keep their size within reasonable proportions. About 100 periods a second is deemed best for the work. It may be objected that fifty volts entail very expensive leads in large buildings. In some cases perhaps this objection will hold good, and a higher voltage would be used, accompanied by a higher period, but it is the pressure best suited to the Ries socket and the 50 volt lamp is probably the most durable that can be made.[1]

It will be seen then that the low tension alternating system for isolated lighting is worthy of serious consideration. It is novel in so far as it possesses the quality of adjustability ; it enables the current to be taken from the machine without any rubbing parts ; it is quite simple and durable ; it admits of economical arc lighting ; and, lastly, the sphere of usefulness for the incandescent lamp is greatly extended, and is, in this system, quite applicable to bedrooms, hospitals and other places where on other systems it is so unsuited that it is for the present excluded in favor of gas. Indeed, the adjustability of this system to all requirements leaves nothing to be desired, and in this respect it is both unique and perfect.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—V.

BY

Francis B. Crocker and S. S. Wheeler.

CHAP. IV.—*Continued.*

Compound Dynamos in Parallel.—Since the field magnets of these machines are wound with series coils as well as shunt, the coupling of them is a combination of the cases of the shunt and the series wound machines just described.

Fig. 13 represents two compound machines in parallel.

Assume that one machine is already running, that switches F' in the shunt circuit and S^1 in the main circuit are closed, and that armature No. 1 is generating its full current and feeding the lamps on the main circuit, the shunt and series field coils of the machine carrying their proper current. Now to throw on the other dynamo, its armature No. 2 is brought up to normal speed, switch F^2 is closed, which excites its shunt coil. Switch E, on the "equalizer" is then closed, which excites its series coil with part of the main current from No. 1. The second machine then gives its full voltage, and its main switch S^2 is then closed and the voltage of the machine is regulated to make it produce its share of the current for the main circuit. It would be well to actually compare the voltage before closing the main switch, as just described for shunt machines, making the voltage equal at first, so that the machine generates little or no current, and then raise it till the machine does its share of the work.

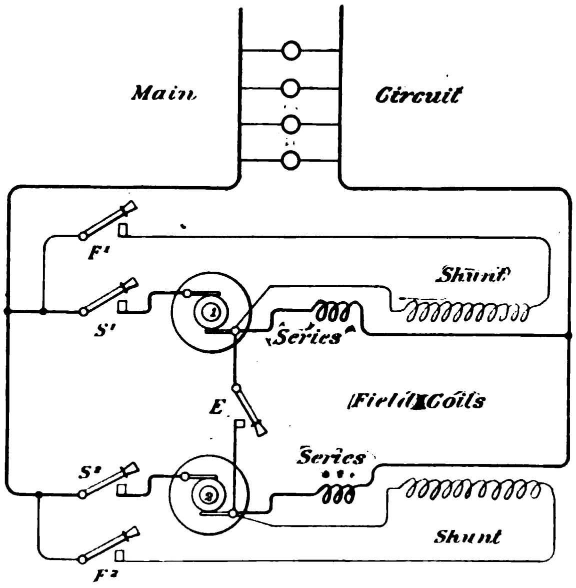


FIG. 13.—COMPOUND DYNAMOS IN PARALLEL.

In disconnecting a machine the same steps are taken, only exactly in the reverse order. More than two compound machines may be run in parallel in this way by connecting them in a precisely similar manner.

Compound dynamos of different size or current capacity may also be coupled in this way, provided of course their voltages are equal, and provided also that the resistances of the series field coils are inversely proportional to the current capacities of the several machines, that is, if a dynamo produces twice as much current its series coil should have half the resistance.

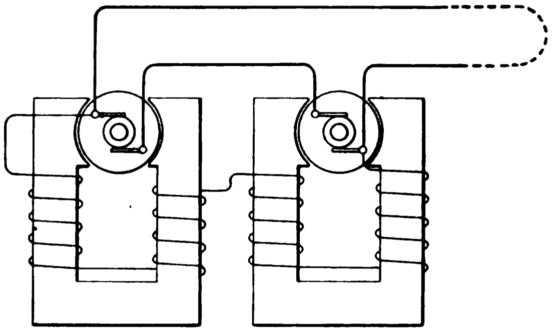


FIG. 14.—SHUNT DYNAMOS IN SERIES.

The switch E is often left closed all the time, in fact, a permanent "equalizing," connection may be made between the corresponding brushes of two or more machines. This has the effect of "compounding" the dynamos collectively instead of individually. For example when only one dynamo is working, its current divides among the series coils of all and these coils will not be highly excited, when however all the dynamos are working the whole current of each will pass through its series coil. Thus the greatest field strength and therefore voltage is produced when most needed—at full load. The equalizing conductor should be able to carry at least half the full current of one dynamo. This method of running compound dynamos in parallel is important because it makes the effect of the series coil proportional to the total load, not to the load on each machine. This is particularly desirable in central stations or where the dynamos are "overcompounded." Compound dynamos run in parallel in this way, as well as shunt machines, tend to steady each other, for if one happens to run too fast, it has to do more work which opposes the increase of speed, and it also takes part of the load off the other machines which will therefore tend to run faster, thus producing equality. This mutual regulation will take care of any slight difference between machines such as the slip of belt, but the difference must not be great.

Alternators in Parallel.—Since the alternating current consists of waves, it is necessary, in order to properly connect alternators together, that they should agree in two respects—first, in *frequency* or the number of waves produced per second, and second in *phase*, that is, they should be at corresponding points of the current waves at the same instant. The case is precisely similar to that of two persons walking together, they should not only have the same *rate* but they should also be in *step*. If an alternator is thrown into circuit with others when not in phase it will cause several severe fluctuations in the lamps, and then the machines will bring each other into unison since they exert a mutual control on each other, similar to that just described in the case of compound machines, only much stronger. In fact, an alternator resists being thrown out of step with others by an amount equal to the full torque or pull required to drive it.

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[1] Since writing this, the writer has obtained excellenr results with 175 periods a second. The choke coil sockets are considerably smaller than the general size: in fact, they need be but very little larger than ordinary key socket. It stands to reason that a much better result can be obtained when the dynamo is adjusted to suit the socket than when this latter has to conform to a certain fixed system.—W. S. H.

Therefore to throw an alternator into circuit with others, bring its speed up to the proper point, regulate the field exciting current to make the voltage of the machine equal to that of the circuit.

The phase may then be determined by connecting one lamp to the secondary circuits of two transformers at the same time, one in circuit with the machine to be switched in and the other on the main circuit. The secondaries of, say, 50 volts each should be connected in series with each other and to a 100 volt lamp. When the machines are opposed the lamp is dim and vice versa. If the lamp flickers badly the phase is not right, but if the lamp is steady the machine is in phase and it may be connected by closing its main switch without disturbing the circuit. If dynamos are rigidly connected to each other or to the engine so that they necessarily run exactly together, there is no need of bringing them into step each time, but they should be adjusted to the same phase in the first place.

Dynamos in Series.—This arrangement is much less common than parallel working and does not usually operate so well. The conditions are exactly opposite in the two cases.

To connect machines in series the + terminal of one must of course be connected to the — terminal of the next and so on. If dynamos are in series each of them must have a current capacity equal to the maximum current on the circuit, but they may differ to any extent in E. M. F.

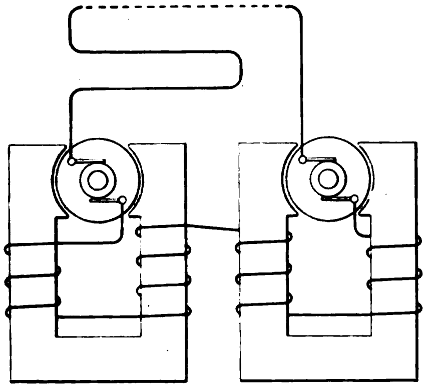


FIG. 15.—SERIES WOUND DYNAMOS IN SERIES.

The voltages of machines in series are added together, and therefore danger to persons, insulation, etc., is increased in proportion.

Shunt or Compound Dynamos in Series may be run well, provided the shunt field coils are connected together to form one shunt across both machines as indicated in Fig. 14.

Series Wound Dynamos in Series may be connected in the simple way represented in Fig. 15, but usually machines are connected in series for arc lighting when, for example, two forty-light dynamos are run on one circuit of eighty lamps, in which case the dynamos usually have some form of regulator. These regulators do not work well together because they are apt to "see-saw" with each other. This difficulty may be overcome either by connecting the regulators so that they will work together or by setting one regulator to give full E. M. F. and let the other alone control the current. This latter plan can only be followed when the variation in load does not exceed the power of one machine.

Alternators in Series.—The same mutual regulating tendency which makes alternators run well in parallel causes them to get out of step and become opposed to each other in series. It is impracticable to run them in series unless they are rigidly connected to run exactly in phase so that they add their waves of current instead of counteracting each other. This is a case that rarely arises in practice.

PHYSIOLOGICAL OBSERVATIONS AT THE McILVAINE ELECTROCUTION.

BY

A. E. Kennelly

THERE are certain physiological facts brought to light in the last electrocution at Sing Sing, N. Y., on the 8th inst., which have a certain importance from a purely physical point of view, especially as this has been the first occasion on which the particulars of the event have been published under the revised legal enactment.

The electrical pressure at the electrodes was determined from a Cardew voltmeter in circuit with a non-inductive resistance. The current passing through the electrodes was observed from a direct reading dead beat ammeter, and the indications of these carefully calibrated instruments afford reliable inferences as to the resistance of a human body, under definite conditions of surface contact, to an alternating current making some 150 periods per second.

From the official records as already published it would appear that in the first application the pressure at electrodes was maintained at approximately 1,600 volts and the current which commenced at 2.0 amperes steadily increased during the 50 seconds of contact up to 3.1, indicating a resistance between electrodes diminishing from the initial value of 800 ohms to a final value of 516, a reduction during the interval of more than 35 per cent. The electrodes were metal plates in large wooden receptacles nearly filled with tepid salt water, and in which the hands of the criminal were immersed. Judging from the fact that although the skin of the hands was blistered over the areas above the water level that had been wetted by first immersion and then withdrawn, yet the skin that remained immersed was entirely uninjured, it seems reasonable to suppose that no very large proportion of the whole resistance of the body would reside in the integuments at the electrodes.

In the second application 43 seconds later, the pressure was observed to be maintained at approximately 1,500 volts, and the current which passed between the forehead and the calf of the right leg continued at 7.0 amperes during the 36 seconds of contact, indicating a resistance practically steady at 214 ohms during that time. The electrodes were of sponge kept thoroughly wetted with cool salt water and backed by metallic plates, the area covered by each being about 100 sq. cms. Since no blistering took place immediately beneath the head electrode, although some blistering occurred at the other, it would appear that no large proportion of the total resistance existed in the contact areas.

The mean activity developed in heat during the first application was thus 4,080 watts and in the second 10,500 watts or about 14 E. H. P., this large expenditure of energy accounting for the considerable post mortem temperatures that are stated to have been observed.

The average resistance of the human body between the hands immersed to the wrists in dilute solutions of salt or soda, is often overstated in measurement owing to the vitiating influence of polarization on observations taken with feeble currents in the Wheatstone bridge. Correct readings can, however, be obtained either by bridge measurement to "immediate false zero" or by the use of large resistances inserted directly in the electrode circuit through a galvanometer so as to employ a higher pressure without pain to the subject and so reduce the influence of the possible 2.5 volts of polarization counter E. M. F. In either case the mean resistance under these conditions is about 1,000 ohms.

The inference appears to be drawn that the resistance of the body between hands to an alternating pressure of 1,500 volts is only about one-half what it is to continuous pressures of 5 volts or to alternating pressures of 2 or 3 volts, and from the observations above mentioned it would seem that the resistance between forehead and calf is very much lower than between immersed hands. While in conclusion the general belief is further substantiated, that the quantity of current which may pass through the body from a contact with high pressures will entirely depend upon the area and moisture of the contact surfaces, being large with extended and wet surfaces, but perhaps comparatively small for brief contacts on dry and limited surfaces of touch.

PORCELAIN AND GLASS INSULATORS.

BY

James Bowstead Williams M.A.C.

Having spent several years in the practical examination and use of insulating materials, I would like to contribute to the columns of the Engineer some of the results obtained from actual tests of glass and porcelain insulators now in general use. These tests were made with a quadrant electrometer designed and made by myself in 1886, for the express purpose of testing insulating materials by means of charges of several thousands of volts, and upon the indications of which I could rely.

My method of testing the insulators is substantially as follows: I take a "pony" glass insulator, mount it upon an insulating pillar, and secure a fine wire in the groove which is intended for the reception of the line wire. The fine wire is then connected with one pair of quadrants and charged to a potential of about 5,000 volts. As long as the insulator remains untouched by any conducting body no leakage of the charge occurs, and the spot of light will remain stationary at one end of the scale for hours; but the instant *any* portion of the insulator is touched with the finger, or even with the point of a pin, the charge escapes and the spot of light rapidly passes down the scale to zero. If a large porcelain insulator is subjected to the same conditions as the glass insulator, the charge also escapes, but not so fast, and the spot of light passes down the scale to zero a trifle slower than when the glass is touched.

Now, if these insulators are washed perfectly clean, and dried without touching the outer surface, and then tested as soon as dry and cool, their insulation resistance is practically infinite, using the same potential as before. If we allow either of them to remain on the insulating pillar and untouched for a few minutes, in an ordinary atmosphere, and then test as before, we find that there is some leakage; and this leakage continually increases until, in from one-half to one hour's time, according to the state of the weather, it is almost as great as at first. The reason why it is not quite as great as at first is because there is only a film of moisture, for the conducting body, on the surface of the insulator; whereas, when purchased, the insulator contained a conducting film composed of moisture *plus* dirt. If we compare the amount of leakage of the glass and porcelain insulators we find that the amount is less on the porcelain, and that it does not augment as rapidly as it does in the case of the glass, after both have been cleaned and dried.

Then why is the surface leakage of the glass greater than that of the porcelain? For it is over the surface that the charge escapes, and not through the mass. And why does it not increase as rapidly in the case of the porcelain as it does in that of the glass? In order to answer these questions to my own satisfaction, I tested many kinds of glass and found that the richer the glass was in silica (as I believed) the higher was its surface resistance, and therefore its specific resistance. In fact, I once found a flint glass vessel, having about the same surface area as that of the ordinary glass insulator, a vessel that had been handled for some time without being washed; and yet there was no surface leakage, even when a zone or band of tinfoil was placed on the glass about one inch from a fine wire secured around the vessel and the tinfoil electrically joined to the earth. If the vessel was filled with water and emptied, and then tested, there was still no leakage. These tests, were made in San Francisco, in the summer time when there is always considerable moisture in the air, and the insulators tested were those supplied to the trade, and of Eastern manufacture.

From the many experiments and tests I have made I concluded that the best answer to the above questions I could make to myself—whether the answer will satisfy others I do not know—was simply this: The glazing on the porcelain insulators contains more silica and less alkaline matters and metallic oxides than the body of the glass insulators.

How can the present trouble be remedied? If the leakage over the surface of the insulators can be prevented we need not trouble ourselves much about leakage through the mass, unless the compositions contain a considerable amount of ingredients which conduct electricity. Secure a pretty wide zone or band of highly insulating material, somewhere on the inner surface of the bell, of glass or porcelain insulators, the insulating material to be to a high degree anhygroscopic, and which can be renewed from time to time as required, and surface leakage will be prevented on those insulators just as long as this material is kept free from dust and moisture, provided the material does not deteriorate or change by exposure to the atmosphere.

The writer has often wondered whether a "double bell" insulator, with its inner bell formed of glass containing a large proportionate quantity of pure silica, and well protected from rain, dust and mechanical injury by the outer bell, could not be made, which would afford sufficient insulation for wires carrying high-tension currents. It is evident that if the stems which support the insulators could be made to possess good insulating properties the more efficient would be the insulation of the line wire.

NOTE ON THE ELECTROMOTIVE FORCES OF BATTERIES.

BY

Townsend Wolcott.

In his article in your issue of December 30, Mr. Maurice Oudin mentions the fact that the calculated E. M. F. of a battery does not always agree with the observed value of the same, and then passes on with a mere conjecture as to the cause of the discrepancy. A little study of the matter, however, will show ample cause for all differences.

We know that a given amount of electrolysis in the cell represents a given quantity of electricity; further, that this same electrolysis represents a definite quantity of energy furnished by the chemical action. Now if we divide the energy by the quantity of electricity we obtain the E. M. F. which the battery would give if all the energy from the chemical action went into the current. Even though we were entirely without experimental data regarding actual batteries, we would have no right to expect (according to the theory of probabilities) that the efficiency of conversion would be exactly 100 per cent. in all, or in even a majority of cases, and if cases of 100 per cent. conversion were found they should be regarded as exceptions.

But, as a matter of fact, we are already in possession of sufficient data to speak more definitely on the subject. No theory of a cell would be complete without taking account of every bit of work done in the cell. For instance, in the ordinary "gravity" cell, there is dense copper deposited on the bottom, and the centre of gravity of the cell is somewhat lowered, and energy is given out. This energy must either go to heating the solution or else be added to the electrical energy by increasing the E. M. F. of the cell; which we cannot assert without an intimate knowledge of everything which takes place in the cell. However insignificant the amount of this energy from a practical point of view, it illustrates a theoretical principle just as well as though it were larger in amount.

There is, however, a much more important principle concerned, namely, that the energy from a chemical action is, in part at least, subject to the laws of thermodynamics. We know the electro-chemical equivalents of most substances with a degree of accuracy which is probably all-sufficient for practical purposes, but the energy of chemical action has not been so accurately ascertained, and even if it had been under given conditions, it does not follow that the conditions would be fulfilled in the battery cell.

When a body passes through a cycle of changes regarding temperature and volume, it is not sufficient to know the initial and final states of the body in order to compute the total energy given off or absorbed, but the state of the body at each instant of the intervening time must be known. We may know exactly what chemicals we put into a battery when we charge it and what we throw away when the cell is exhausted; but, unless we know the exact history of the whole for the intervening time, we cannot calculate the thermodynamic part of the E. M. F.

We know that the E. M. F. of all batteries is more or less affected by a change of temperature, and it would seem probable that a cell whose E. M. F. increases with the temperature might in some cases even absorb heat from surrounding objects and convert it into electric energy. Or, at all events, we should expect to find the reverse; that is, if we had a battery which was found by experiment to absorb heat and convert it into electrical energy, we should expect to find that it had a positive temperature coefficient. For, supposing the cell enclosed in a heat insulating case, the refrigerating action of the current would gradually use up the whole supply of heat and the E. M. F. must sooner or later drop to that value which it would have without the absorption of heat, so that the temperature coefficient would, on the whole, be positive, though not necessarily following any predicable law.

In a battery with a positive temperature coefficient we must either show that the actual available energy of the chemical actions is greater at a higher temperature, which is not particularly likely; or else assume that the efficiency of conversion is higher, perhaps above 100 per cent. Suppose the efficiency of conversion less than 100 per cent.; then the surplus energy of combination, after doing what mechanical work (if any) was necessary upon the contents of the cell, would go to heating the latter. Now, supposing the cell enclosed, as before, in a heat insulating case; we are not so sure of the result as before, but it is most probable that the temperature coefficient is negative, as in this case the accumulation of heat would tend toward a finite limit. The only way of reaching a finite limit with a positive temperature coefficient, is to suppose the efficiency of conversion to increase faster than the heat accumulates, until no more heat is given off, beyond which point heat would be absorbed.

ELECTRICAL HORTICULTURE.

A Paris electrician has succeeded by means of his battery in forcing violets. The first bunch, it is said, was raised in four hours, at the end of which time it was plucked, tied with a ribbon and sent to the ex-Empress Eugenie. It would be interesting to learn just how much truth is contained in this statement.

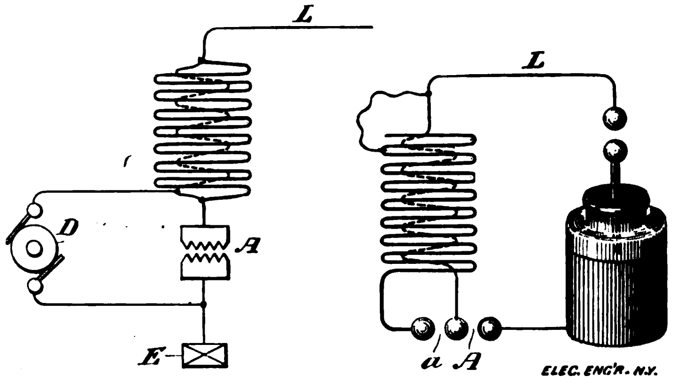
INDUCTION BY HIGH POTENTIAL DISCHARGES.

BY

Elihu Thomson

It is well known that electric lines are strongly affected by induction during thunder storms, and it would naturally be inferred that a line in a direction parallel to the flash would receive the strongest inductive influence, and that the induction would not necessarily be static induction, but currents would be set up by dynamic induction, complicated in many cases by static inductive actions occurring at the same time. What are known as "return strokes" in lightning flashes, according to this view, may be nothing more or less than parallel induced discharges along fairly good conducting paths, and it is possible that in the neighborhood of a lightning flash such induction may be of a very intense character. These considerations led to my making the experiment of inducing, by a Leyden jar discharge, passed through a single turn of insulated wire, a discharge in a ring shaped vacuum tube placed alongside, which was found to illuminate the vacuum. Similar experiments had been made and published by Prof. J. J. Thomson.

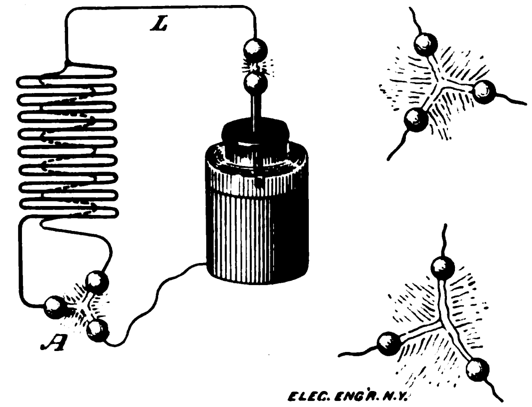
In working to devise a means for the protection of electrical apparatus from the effects of such induced discharges of lightning, it occurred to the writer to employ the inductive effects of the discharges to counteract, as far as possible, the effects of such discharges, or, as it were, to interpose a barrier between the discharges and the apparatus to be protected. This gave rise to a lightning discharge protector or lightning arrester, the principle of which is shown in the accompanying sketch, Fig. 1. Let L be a line leading from the dynamo or other electrical apparatus and subject to induction from lightning discharges, or subject to lightning discharges themselves, as in a railway trolley line. Let D represent a dynamo with one terminal grounded and the other connected to line. In such a case were there no provision for protecting the dynamo D from a lightning discharge it would be in danger of injury in case of induction occurring along the line or in case of a flash reaching the line. To avoid this I place between the dynamo and the line a sort of induction coil which consists of a double coil, each coil being made of a few turns of coarse wire, highly insulated from each other. One of the coils may be wound upon the outside of a glass cylinder and the other may be wound in the interior thereof. Both are connected to line at one end, as shown, and one or both are connected to earth through the discharge plates of a lightning arrester A provided with an arc rupturing device, such as a magnet to blow out the arc in case the potential of the dynamo is high enough to maintain such an arc. The coil in the dynamo circuit has been found to need a few more turns than that in the earth circuit and the di-



Figs. 1 and 2.

rection of winding in the two coils is such that they are opposed in their inductions, or that a discharge passing from line to earth through one of the coils tends to induce a discharge in a direction towards the line in the other coil, or the coil in the dynamo circuit.

The manner of experimenting to determine the relation of the coils was substantially as follows: A double coil was made, Fig. 2, in which the inner turns were about 12 and the outer turns 20. These were kept separate from each other and a branch wire taken from the line and slid from point to point on the outer wire enabled the effective length of the same to be adjusted. The inner coil was connected through a small spark gap, as at A, to the outer coating of a Leyden jar, while the wire L was brought near the pole of the jar which was continually being charged from a Toepler-Holtz machine. The discharge in passing from the knob of the jar to the wire L, representing the line, passed by the inner coil. When a certain length of the outer coil was employed only a very short, almost imperceptible spark was obtainable at *a*. If the balance of the turns were disturbed by including more or less than the proper number of the outer turns, not only did a vigorous spark occur, but the gap at *a* could be quite considerably extended, in accordance with the amount of departure taken from the proper number of turns required to produce the balance. This experiment indicates that it is possible to make a selective path for the Leyden jar discharge and to have, as in Fig. 1, a structure so proportioned that the discharges reaching line will pass to earth without tending to go through the circuit of the dynamo D. The action is apparently due to a balance of electromotive forces such that the discharge which tends to pass from the line in going to earth induces in the coil connected to the dynamo a counter-electromotive force which nearly wipes out the potential of the discharge before it reaches the dynamo. This balance of inductive effects is certainly very striking, and once obtained, it is disturbed, as, in the experiments, by changing the relative lengths of the coils in inductive relation through so small an amount as an inch or two.



FIGS. 3, 4 AND 5.

It may be mentioned here that some curious effects of spark were obtained in these experiment. When a disturbance of the balance exists and a spark is obtained at *a*, the character of the spark is different from that of the Leyden jar discharge. It appears to be less luminous, the noise less sharp and its color would indicate a greater power of volatilizing metal and perhaps a greater duration. It is in part, no doubt, due to a current local to the coils in series with one another.

Another curious effect was the production of **T** shaped and **Y** shaped sparks, or three-branched sparks—such as are shown in Figs. 3, 4 and 5.

These were obtained by separating the electrodes at A an inch and a half or thereabouts and bringing the third electrode from the outer coil to the position shown in Fig. 3. The discharges were now obtained as before from the charged jar. In this case the discharge appears to split and unite in air, producing the curious shaped sparks shown. It would seem that to obtain these effects—particularly the sparks which were three-branched from a common point in the centre between the discharge electrodes—the dielectric air must break down simultaneously between the three electrodes. It would easily explain the **T** shapes to assume the straight part above to form first, and the cross or transverse spark to strike from the side of this spark to the third electrode.

The induction effects obtained with the apparatus described soon led the writer to reason that the passage of heavy condenser charges through a coarse wire primary coil of few turns might be made to induce in a finer coil of more turns wound parallel thereto discharges of much higher potential and less current. In this case the Ruhmkorff coil would, as it were, have its primary subjected to the oscillations of a condenser discharge of high potential, instead of low potential battery discharges raised in potential by the condenser and interrupter.

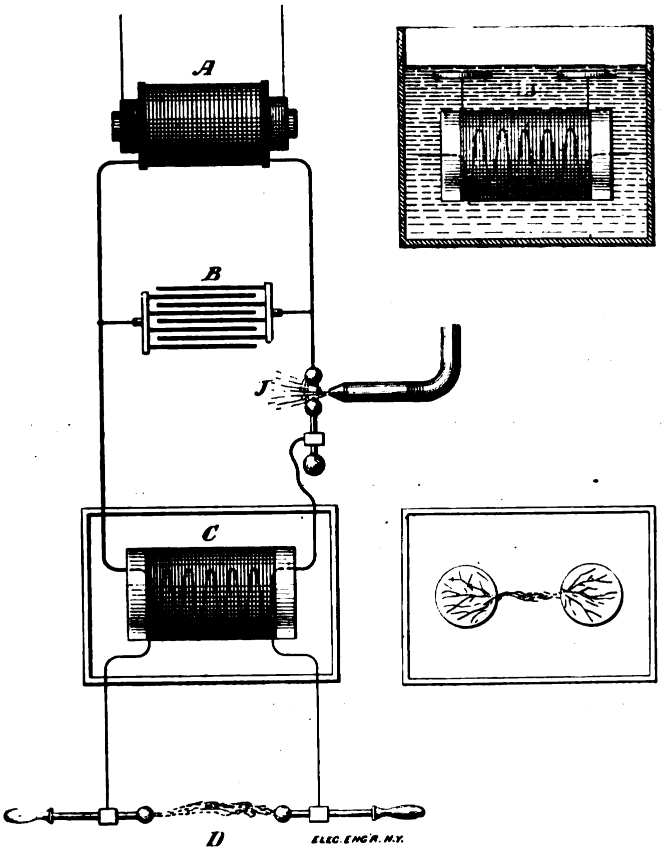
On trying the experiment with a coarse heavily insulated wire coil of about ten turns enclosed in a glass tube, without any iron core, and with a secondary of one layer of fine silk covered wire outside the glass, it was found that the passage of the Leyden jar discharges of about ½ inch spark in the coarse coil would give rise to such high inductive effects in the secondary as to spark from turn to turn in the single layer. By immersing the whole in a jar containing insulating oil, however, the insulation of the turns was better kept and sparks of two or three inches were obtained between the terminals of the secondary at every discharge of the jar. The glass tube used was about 2 inches in diameter and about 5 inches long. There were about 120 turns in the secondary layer. The induction must have been at least as high as from 100 to 150 volts to the inch of wire. It was soon found that the glass tubes ⅛ of an inch thick were frequently punctured under the oil, and that the spark of the jar could not be unduly lengthened without producing discharges under the oil or between turns of the secondary.

The sparks from the secondary were peculiar in that they appeared to be prolonged and quite like those of a Ruhmkorff coil worked in the ordinary way but with small condensing surfaces on each terminal of the secondary.

Arrangements were now made to obtain frequent condenser discharges at high potential and to carry on the experiments on a much larger scale. The results have shown that it is now in our power to obtain torrents of long sparks, and that this may be done without any very great expense for apparatus, the expense being very great in the case of the large Ruhmkorff coils hitherto made. Sparks of two or three feet long will, I think, be readily obtainable. The sparks are like those obtained from small jars and if the terminals be connected to jars in the same way as the condensers are attached to a Holtz machine the thickness of the sparks can be increased at the sacrifice of length.

I will now describe the apparatus I use. This will give a torrent of sparks of 7 to 8 inches in length making a loud roaring sound and the length of spark seems limited only by the capacity of the secondary coil to maintain the insulation. This will be improved in the next construction.

In Fig. 6 is shown a view of the apparatus used. A is a large induction coil or transformer capable of using in its primary ordinary alternating lighting currents of 50 to 100 volts and transforming up to 10,000 to 12,000 volts alternating. So used it will spark over ½ inch to one inch between its terminals and give the uprising thin arc now well known. A blast of air blown on such an arc charges it into a beautiful pale purple flame. A condenser B the capacity of which can be changed, is connected to receive the current from the secondary of the A. The spark or arc with moderate condensing capacity is not much changed unless a blast of air be blown upon it. In this latter case it becomes a most beautiful electrical phenomenon. It becomes a mass of flame filled with fine and thick shreds representing the condenser discharges, a gorgeous network of electric fire changing with any change of the pressure or direction of the air blast. Sometimes, as on breaking the primary circuit, the oscillations of charge and discharge are seen as minute parallel lines or sparks on the borders of the flame joining the terminals. With greater condensing surface the discharge between terminals becomes more thick and white even without the blast, and when a forcible air jet is turned on it roars very loudly. At C is a second and peculiar transformer, the primary of which is an open helix of but a few turns, about 15 or 20 convolutions, of heavily insulated line wire, about four or five inches in diameter. This is surrounded by a thick glass cylinder upon which has been wound say 150 turns of fine silk covered wire in one layer with a silk thread between the turns so as to cause the turns to be well insulated laterally.



Figs. 6, 7 and 8.—Apparatus for Obtaining High Potential Discharges.

This simple induction coil is now immersed in a jar of heavy oil and the terminals, on leaving the oil, are kept as far apart as possible and surrounded by glass tubes. The terminals of the coarse and short primary are connected in circuit with the discharge balls upon which the jet of air plays at J. The finer secondary terminals are connected to discharge terminals, as at D, for obtaining the spark. On passing the alternating current in the primary of A and adjusting the spark gap and jet at J, as well as the distance between the discharge terminals at D, it is easy to obtain sparks of 7 to 8 inches in a perfect torrent at D, while sparks of $\frac{1}{4}$ inch are passing at J. In fact coil A and condenser jars B constitute the source of very rapid electric oscillations and correspond to the primary battery and condenser of a Ruhmkorff coil, while the air jet and spark gap at J bear a similar relation to the interrupter.

The discharges obtained at D represent, it would appear, at least 150,000 volts in potential, or about a thousand volts to each turn of the secondary. The potential may be higher, for we have no data of spark length at such high pressures. It should be mentioned that the limit of spark was apparently that of the insulation of the secondary turns, for on attempting to increase it by separating the terminals at D to over 8 inches, the sparks jumped in the jar of oil and could be seen passing under the oil from the secondary to the primary wires. Were it not for the required insulation between the turns of the fine wire secondary of C, they could be wound in one layer so as not to cover more than two or three inches of the glass cylinder and could be made to give out sparks of a foot or more in length. The volts per inch of wire obtained in these experiments are extraordinary and it is quite certain that the limit will depend on the insulation. We are now possessed of the means for obtaining artificial lightning in a steady stream, and can experiment at will with extremely high voltage. The advantages of oil insulation are emphasized by these experiments, and although sparks frequently passed under the oil the insulation renewed at once.

It is necessary that the coil C be sunk well below the surface of the oil as otherwise the discharges will perforate the oil layer at each end and pass over the surface. It is curious to note the agitation of the oil over the coil when the apparatus is in action and the coil is not deeply immersed and yet sufficiently so to prevent discharge.

A curious discharge without electrodes is obtained by providing each terminal of the secondary layer C with a metal plate which the oil just covers, the plates being parallel to the oil surface, Figs. 7 and 8. Great agitation of the oil over the plates ensues, and sparks pass over the surface of the oil and spread over the surface just above the plates. If the oil layer be too thin it is perforated by discharges passing from plate to plate, and oil is scattered. Geissler tubes are lighted in the vicinity of the coil, outside the jar or near the terminals, an action long well known in the case of the working of Ruhmkorff coils of considerable power. The frequency of the alternations used was 125 or 250 alternations per second. By raising the alternations the spark torrent will be more continuous. On the completion of still more powerful and perfectly insulated apparatus, the effects will doubtless be greatly enhanced.

The experiments demonstrate that lightning discharges, aside from electrostatic effects, may be the source of most vigorous electro-dynamic inductions, and that high potential discharges may result. The bearing of this on a "return stroke" has already been mentioned.

It may also be pointed out that in the electro-dynamic inductions set up we have a means for the study of the rate of oscillation, potential and current of lightning discharges which are now but little understood. It is too much to assume that all such discharges take the oscillatory character of Leyden jar discharges, and it would be useful to distinguish between rates and characters of discharge. The writer remembers that during a storm a few years ago he noticed a ringing or humming sound accompanying a not very distant flash of lightning. The sound was remarkably clear and almost musical. Could it have recorded the oscillations of a discharge in which the capacity and self induction were such as to give the oscillations a defined rate within the ordinary range of pitch of musical sounds? It is an observation which the writer takes the present occasion to record, as a strong impression was made on him on account of the loud, clear, ringing tone which followed the flash.

ELECTRICITY IN AGRICULTURE.

It is stated by our contemporary, the *Electrical Engineer*, of London, that W. W. Rawson, market gardener, of Arlington, has found that the use of electric light has increased his profits from the growth and sale of lettuces, etc., by more than 25 per cent.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XIII. NEW YORK, FEBRUARY 17, 1892. No. 198.

The good engineer aims not only to attain his results, by the best means, but to attain only such results as will pay.—Ashbel Welch.

MR. EDISON'S MISTAKE.

IN the consolidation of the Thomson-Houston and Edison companies, the former comes out a little ahead, in many ways. The discontinuous, frequently changing, though often able, organization and management of the Edison interests have doubtless contributed largely to bring about this result, but may not a more fundamental cause be found in the attitude taken, and persistently held, by Mr. Edison towards alternating current distribution? He could see no merit in that system. But upon its advent, its possibilities were promptly perceived by others. It was soon reduced to commercial availability, and, since its introduction for long-distance service, six years ago, it has practically driven the direct system from the field of much central station business. Mr. Edison set his face against it as a flint from the first, and has sought on every possible occasion to discredit it through the weight in the community of his justly great name. But the tide would not turn back at his frown. A great prestige may often prevail against arguments merely, but not against established facts. It is both interesting and pleasing to note, at this time, the extent to which one of Mr. Edison's most deeply rooted convictions has been carried out in the electrical work of the last few years. We mean his advocacy of the multiple arc system of distribution as against the series system. It was soon found requisite to resort to parallel circuits to make alternating current distribution economical, that is, commercially practicable; street railways are operated in multiple; and the use of arc lamps in multiple, on distributing circuits, is constantly and rapidly increasing.

Under whatever name, and by whomsoever conducted, the industries of electric lighting and power transmission will bear the impress of Mr. Edison's genius in many of their most salient features. His name and fame are too deeply impressed upon the world to incur any risk of obscuration through any changes of business or methods.

THOMSON-HOUSTON AND EDISON.

ALTHOUGH awaiting till May 1 the formal assent by holders of a majority of the stock of both companies, the consolidation of the Thomson-Houston and Edison companies is evidently a foregone conclusion, on substantially the plan announced a week ago. The parties to the agreement would hardly have entered into it without possessing a majority control of both stocks. It seems quite reasonable to expect, as many do, and as rumor has it, that the absorption of the Westinghouse Company into the proposed new corporation will soon follow. The provision of $16,600,000 of stock—$6,000,000 of which is in preferred shares—remaining to the treasury after taking up the Edison and Thomson-Houston stocks, is thought by many to imply the use of a considerable portion of it in taking over the Westinghouse Company when convenient; but no definite information of such a plan has been made public.

The title under which the new company will organize is not officially announced, but it is confidently asserted, in several quarters, that it will include neither "Thomson-Houston" nor "Edison." "The General Electric Company of America" has, we understand, been considered as a proper title. But more important than changes of name will be the necessary changes in personnel and in administration. The general office will doubtless be in New York. Current opinion, apparently well founded, assigns the presidency to Mr. Hamilton McK. Twombly, and the general managership to Mr. Charles A. Coffin, now vice-president of the Thomson-Houston Company and its active manager. Mr. Twombly has been prominent in New York financial and business circles for some fourteen years; first as a director and one of the vice-presidents of the Western Union Telegraph Company, in which offices, among other duties, he had the supervision of the purchasing and supply departments as well as of the extensive factory which that company then maintained for the manufacture of its apparatus. Some readers connected with the telegraph service will recall the assiduity, energy and efficiency that characterized Mr. Twombly's participation in the Western Union management. He has, for the past ten or twelve years, been chiefly occupied in railroad and transportation affairs, in connection with the Vanderbilts.

Every one acquainted with electric lighting and power is aware that Mr. Coffin has for years been the daring and successful executive of the Thomson-Houston Company; the leader who has brought it, step by step, in quick succession, to its present commanding position. Mr. Villard, who had just been re-elected president of the Edison General Electric Company, presented his resignation to the trustees at their meeting on Friday last, to take effect not later than April 1.

Changes of one sort and another must be inevitable in the assignment of prominent positions in the managment and the conduct of the combined business of the two companies; but in view of the steady growth of the industry it is quite certain that all persons of approved efficiency will, if they choose, find their services in demand in the work of the new corporation.

MR. TESLA'S LATEST WORK.

THOSE who had the good fortune to attend Mr. Tesla's famous lecture at Columbia College last May, will probably have evinced no surprise on reading the account of his lecture delivered in London, as given in our cablegram last week. It must indeed have been apparent to even the most casual observer that Mr. Tesla's researches had extended much further than the limits of a single evening would permit him to touch upon, while, on the other hand, it was but natural to expect that so skillful an experimenter as Mr. Tesla would make considerable progress during the time intervening between his first lecture and the one just delivered. The latter, is, if anything, even more striking in its results and in its possibilities than that of last May, which came as a revelation to electrical engineers. In it Mr. Tesla has demonstrated not only a number of facts of the highest importance as bearing upon the modern views of the nature of electricity, but has actually shown how to apply some of his results in actual practice. Thus, the operation of a motor running on one wire and even without any connection with the generator would alone have sufficed to make the occasion a memorable one; but the numerous other beautiful experiments performed confirm the opinion, already well grounded, that Mr. Tesla has opened up a new and vast field not only of research but of practical applications. The London Institution of Electrical Engineers and the Royal Institution are to be congratulated on having had Mr. Tesla's latest results first brought out before them, and it is understood that the American Institute of Electrical Engineers will be similarly favored by Mr. Tesla on his return.

TECHNOLOGICAL TRAINING IN CHICAGO.

THE CHICAGO ELECTRIC CLUB has done a very timely and creditable piece of work in setting the ball rolling for the foundation of a technological school that shall be in some degree commensurate with her other institutions and her place as a great American city. The matter was brought up in an able paper by Mr. F. W. Parker and was discussed by President B. E. Sunny and others in a highly practical and forceful manner. From the presence of President Harper, of the University of Chicago, at the meeting, and the fact that he has since conferred with a club committee composed of Messrs. Parker, Sunny and Besley, it looks as though a technological institute, on broad lines, affiliated with the university, may be the result of the movement—very much as the School of Mines is a part of Columbia College in this city. It is an honor to the electrical fraternity that they have been so active in so vital a matter, and we can only hope that in return the work of the new school will take full recognition of the manner in which electrical engineering touches every other interest and profession. Nothing is too good for such a progressive city as Chicago, and she should see to it, therefore, that the training given by her new school is the very best that men and money, and a high ideal, can make it. We note that it is proposed to combine with the Institution a Physical Laboratory and a Museum of the Mechanical Arts. The World's Fair should leave behind it a liberal equipment for both, without cost.

THE BUFFALO ELECTRIC LIGHT CONVENTION.

OUR readers will have gathered from the news already published in these columns and from the programme which appears in this issue that the Buffalo Convention of the National Electric Light Association will be a meeting of great importance and interest—one that is likely to be up to the highest level yet attained by these gatherings, and perhaps, owing to the special conditions of the hour, destined to mark a distinctly new departure in electric lighting development in America. While the exhibitional and social features will wisely be subordinated, they will not be altogether missing, and promise to supplement in due proportion a business programme of unusual strength. The officers of the Association have shown good judgment in this, and as President Huntley is a man with a lucky star, the result may be depended upon as pleasing to everybody. In all probability a year will pass before the Association convenes again, and we advise our electric lighting friends therefore to make the most of this opportunity of reunion.

PORCELAIN vs. GLASS.

THE controversy regarding the relative advantages of porcelain and glass insulators was the subject in our last week's issue of a communication from Mr. Frank W. Jones, electrician of the Postal Telegraph Cable Company, in which he gave the results of actual tests made on these two types, and which demonstrated the superiority of porcelain in the most striking manner in all conditions of weather. In this week's issue Dr. J. B. Williams adds his testimony to that of Mr. Jones, and demonstrates by another method of testing, the superiority of the porcelain insulator. He also adds an interesting note as to the probable cause of this superiority, which he attributes largely to the inferior quality of the glass used on insulators as usually manufactured.

High-Tension Electricity.

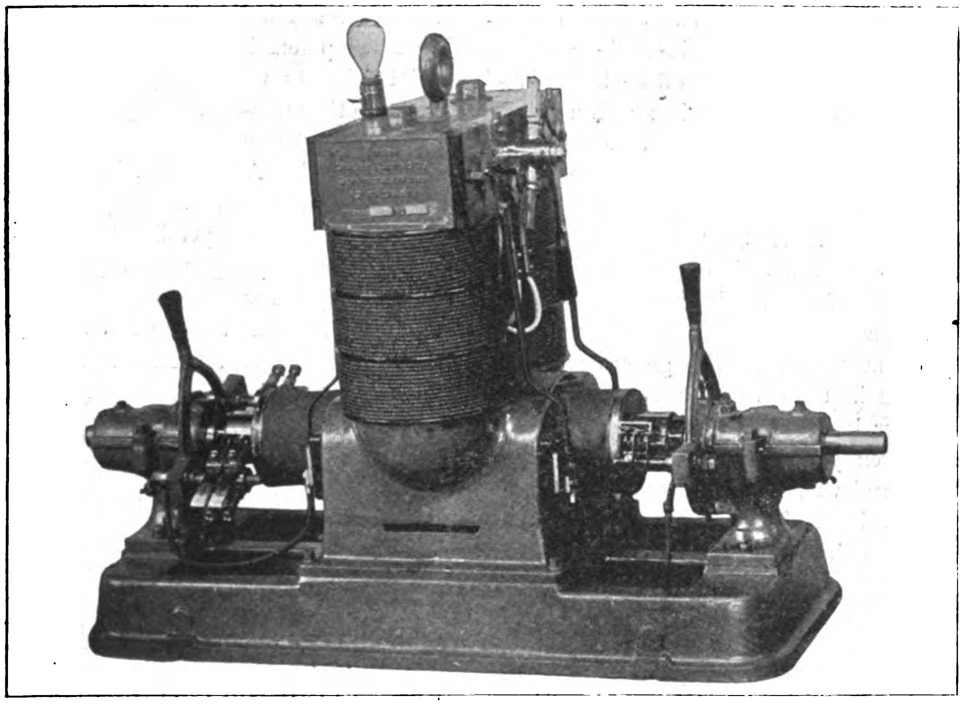
ON another page we print a highly interesting communication by Prof. Elihu Thomson, in which he describes apparatus that cannot fail to fascinate the large number of students and experimenters who are gradually taking up the work of high-tension electricity. The results obtained by Prof. Thomson with such simple apparatus will largely aid in fostering this work, and will, as he suggests, prove specially valuable in studying the nature of lightning discharges and similar phenomena, a subject which is of the utmost importance in its effect on systems of distribution. It may, indeed, be the means of opening up fields in other directions now barely thought of.

THE NEW EDISON MOTOR-GENERATOR.

Another interesting product of the Edison Works which has been called forth by the application of street railway circuits to stationary power and domestic lighting purposes is the motor-dynamo illustrated in the accompanying engraving.

This machine has been designed for special use on street railway circuits, and is employed to convert the current from 500 to 125 volts, thus furnishing a current of low tension for either lighting or power.

The motor-generator, is, as its name implies, a combination of two machines in one. The armature is so wound that it has two distinct windings, and each end is furnished with its commutator, rocker-arm and brush-holders. The engraving shows the appearance and arrangement of one of these transformers, designed for six kilowatt capacity. The dimensions are those of the standard Edison 12 K. W. generator; with the exception of the length of the bed-plate and pole-pieces. The head-board at the motor end of the machine is provided with a double-pole switch, that at the generator end being furnished with a single-pole switch.



The New Edison Motor Generator.

It is evident that this type of machine can be applied with equal advantage to long-distance transmissions where high potentials can be employed at the source of power, such as a water-fall, and reduced to a safe working voltage at the distributing point. On the other hand the machine is equally well adapted to increasing the potential from low to high. These machines are now manufactured in various sizes and for various voltages, the highest being built for 1,200 volts in the primary circuit.

CRYSTAL PALACE ELECTRICAL EXHIBITION.

The Siemens high tension current has been tested at the Crystal Palace Exhibition. Over 50,000 volts tension was obtained, 500 16-candle-power incandescents of 105 volts resistance each being lighted. All were kept brilliantly lighted in series. Some lamps burst, but the current arced over from the platinum wires without fusing them. The current brought by a brass disc on to a thick sheet of plate glass 2 feet by 2 feet square sent off great zigzag streaks of vivid lightning over its surface, continuous, and not in flashes. The results were magnificent.

THE EDISON TRIPLE EXPANSION ENGINE AND MULTIPOLAR GENERATORS.

One of the most serious problems that to-day confronts the management of electric illuminating companies, in large cities, is the cost of the land necessary to accommodate the large station buildings. When land costs $1,000 and upward a foot front, every square foot of ground space that can be saved materially reduces the necessary investment of the company. Recognizing this fact, the Edison General Electric Company have recently brought out a new line of central station units, consisting of two multipolar dynamos coupled direct to a triple expansion engine, and ranging in capacity from 50 to 800 h. p. This combination does away with all belting and countershafting; thus securing an increase of efficiency, and a large saving of floor space—two most important factors in central station practice.

The multipolar generator is peculiarly adapted to this purpose, as it may be designed to generate any desired electrical output, at an armature speed corresponding to that of a slow-speed engine. This type presents the additional advantages of requiring but small floor space, of being able to withstand sudden variations of load, and to carry heavy loads continuously without danger of overheating.

Our illustration represents the 2-100 K. W. combination. The armature, it will be noted, is of the Gramme ring type, of very simple construction. The number of brushes correspond to the number of poles of the generator, and it is found that the large current output can be divided among these brushes much more conveniently, than if only one set of brushes were used to carry the whole current generated. The mechanical device for controlling these brushes allows of their being operated together, so that when once adjusted, the whole can be handled as though but one set were used.

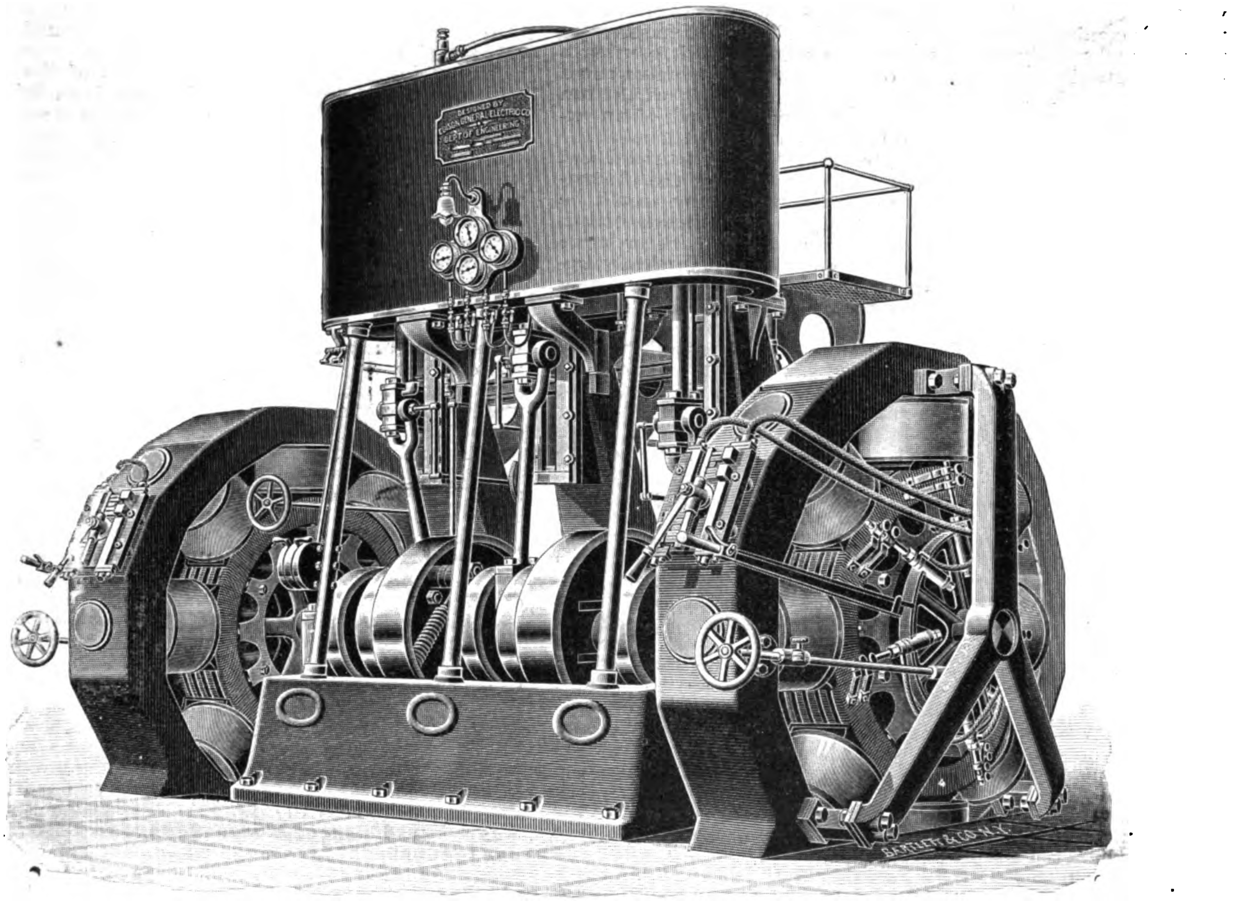
This machine is designed to give 150 volts and 666 amperes at 172 revolutions per minute. The magnet frame consists of a heavy cast iron yoke which has eight inwardly projecting steel pole-pieces. The foundations on which the dynamo rests are cast in the same piece with the bed-plate of the engine, the two supporting feet of the dynamo resting on this iron foundation. The armature spider is placed directly on the engine shaft, and the armature is built up of discs, each disc consisting of two bars. No paper insulation is used between discs.

The armature winding consists of 768 bars, the cross-section of each being 215 mils by 260 mils. The insulation between the bars is 25 mils of shellacked fuller-board. The weight of copper on the armature is 860 pounds and its resistance .005 ohm. The bars that make up the winding are **U** shaped, being joined at the front end in one continuous spiral by means of bars 1¼ inch in depth. These latter bars serve as the cummutator of the machine. The magnet wire is wound on sheet iron spools having fibre ends. Each spool is wound with 113 pounds of No. 10 B. W. G. The total weight of wire is 904 pounds and the resistance of each spool, 1.2 ohm, all spools being connected in series,

The dimensions of the 100 K. W. direct driven dynamo is as follows:

COMPARATIVE FLOOR SPACE REQUIRED BY TWO GENERATORS AND ONE ENGINE.

Two bipolar generators belted to one high speed engine.			Two multipolar generators coupled direct to one Edison triple expansion engine.		
Total capacity two generators.		Minimum floor space in square feet.	Total capacity two generators.		Minimum floor space in square feet.
K. W.	16 c. p lamps.		K. W.	16 c. p. lamps.	
50	900	270	50	900	56
90	1,620	374	100	1,800	121
200	3,600	511	200	3,600	180
350	6,300	571	400	7,200	356



THE EDISON 2-100 K. W. MULTIPOLAR DIRECT DRIVEN GENERATORS.

External diameter of armature body	58	inches.
Length of armature body	13½	"
Radial depth of armature body	4½	"
Bore of field	59⅛	"
Length of magnet core	11½	"
Diameter of magnet core	12¾	"
Width of yoke	14	"
Thickness of yoke	9 1/16	"

The field coils are wound on separate spools, which are slipped over the field magnets; these field magnets are then inserted in an annular or polygonal field frame, mounted on the bed-plate of the engine, the bed-plate being heavy and massive and of special design, so as to secure perfect alignment and rigidity of the field frame with relation to the engine.

The increased diameter of the armature in the multipolar type of machine, gives a very large heat-radiating surface. This point, in connection with the special construction outlined above, allows these generators to maintain heavy loads for long periods, a factor that will be admitted to be eminently desirable in central station work.

The engines are of the marine triple expansion, automatic inverted cylinder type and embody the latest improvements, while operating at the high efficiency obtainable with the compound condensing type. We give above a table showing in a striking manner the economy in space attainable with these direct connected engines and dynamos as compared with belt driving.

THE STANLEY EXPERIMENTAL LABORATORY.

We learn that the Stanley Experimental Laboratory of Pittsfield, Mass., has been reorganized into a stock company consisting of W. R. Plunkett, president of the Berkshire Life Insurance Co.; W. A. Whittlesey, treasurer and manager of the Pittsfield Electric Co.; Wm. Stanley, Jr.; John F. Kelly, C. C. Chesney and Boardman Tobey. The Laboratory is organized for the purpose of forming the central point from which to develop scientific industries.

FLY-WHEEL ACCIDENTS IN ELECTRIC LIGHT STATIONS.—II.

It is possible that failure of a pulley or fly-wheel may commence nearer one edge than the other and thereby tend slightly to disperse the pieces, but the breakage entirely across the face would follow so nearly at the same instant that the component of force due to the velocity in the plane of the wheel would be much the greater, and only such of the flying particles as flew high in the air could disperse laterally any considerable distance. Any piece that was thrown straight up after the roof or other obstructions had been removed would, with an initial velocity of 19,235 feet per second, rise to a height of nearly 1,600 feet or, say, over 1,000 feet, allowing for the resistance of the air, and such piece in falling, if diverted to the slightest extent, might reach to a considerable distance laterally, though such a result would be prevented by obstructions in a building. One of the most interesting experiences during the bombardment of Forts Jackson and St. Philip, on the Mississippi River, during the war, by the Porter bomb fleet, as told by soldiers of the Southern army afterward, was the way in which the pieces of shell scattered. In most cases the shells coming down nearly vertically buried themselves in the mud and merely threw up a large volume of it, causing a general scattering of the groups of soldiers for the moment and a laugh afterward. Sometimes men playing at cards would run like mice to the casemates and avoid the direct result of an explosion and then be back as quickly to their positions in the game, and on several occasions after they had all returned and were laughing over the last Yankee shot and noting the discomfiture of some one who was covered with mud, they would be startled by a sudden whirr and the "lazy piece," as it was called, would come back from the skies and perhaps injure one or more of them. The "lazy piece" meant one thrown vertically upward at the time of the explosion and which, therefore, being unobstructed rose to a great height and took considerable time to rise and return.

It was also claimed by defendants that if the jack pulley broke before the main fly-wheel and pieces of the former were carried on the belt underneath the latter, the upward strain would not necessarily break the fly-wheel, or at least not without breaking the frame of the engine or the pillow blocks, cap or bolts, which was not the case. The plaintiffs showed that the frame of the engine had been racked, but this the defendants accounted for by the shaking of the engine on its bed when running away.

The defendants, the insurance companies, after answering the theories of the plaintiff, claimed that the whole accident was caused by the running away of the engine, due to the slackness of the governor belt or the slipping out of the lacings, whereby the governor acted rather slowly or entirely ceased to act. No safety attachment was provided for such an emergency, but the engineers have applied one since the accident. As to the cause of the fire, it only required a little moisture on the wood of the tower to which the lightning arresters were screwed to cause a slight leakage between the terminals of the dynamos when a very moderate increase of electromotive force would cause additional current to cross the shunt formed by this leakage and char the wood so that it would become a good conductor and thus form a short circuit, which, though only throwing out, say, one-fourth the lights, would start the woodwork in a blaze and cause the slight damage by fire in the tower, which apparently cost only about one hundred dollars to repair.

It was in evidence that the governor belt was new, though this was denied by the engineer in charge. An engine controlled through a governor belt with the lacing coming out would accelerate speed quite rapidly, and the speaker claimed that if the current regulator of a dynamo required 10 to 15 seconds after a short circuit to control the current as claimed by plaintiffs' experts, it would also fail to promptly control the current due to a rapid increase of voltage from a rapid acceleration of the speed of the engine and dynamo and therefore cause a short circuit and the fire, and that at any rate it was doubtful if the regulator could control the current within unusual limits such as would obtain if the speed of the dynamo were doubled; or much less if it were raised from 850 to over 3,000 revolutions per minute, as would have been the case if the engine ran away. In answering this the expert of the Thomson-Houston Co. made another close distinction, as he claimed that though the regulator was slow in checking an electrical phenomenon like a short circuit, still, being itself operated by electricity, it really changed at a faster rate than it was possible to cause a mechanical change, such as an acceleration of the engines. This by no means follows, as it will be shown that the engine would quadruple its speed and that of the dynamos in 70 seconds or less, according to the work being done. The Thomson-Houston Company's expert, moreover, acknowledged that it was doubtful if the regulator would control the current when the speed of the dynamo increased to more than 1,700 revolutions per minute. The insurance companies also put in the evidence of an electrician, that one of the station transformers was burned out, indicating increased speed of the alternator and exciter, but the other side denied this. The plaintiffs put in testimony that any increase of speed would have been noticed at the start, but evidently men occupied with a fire might not observe it. The roaring noise heard by the fireman could not have been that due to a short circuit which instantaneously caused the break on the theory of the plaintiffs, as the noise and the breakage were, according to such theory, coincident and over in an instant. A man who was called from the fire-room, therefore, could not have heard the roar, so-called, of a short circuit before the breakage occurred. He could, however, have heard the increased buzz due to the more rapid passage of the gaps between the commutator segments under the brushes. The defendants naturally suggested that the man did observe that the engine was running away, and that the watchman went to the throttle valve for that reason and commenced closing it, but by that time the speed was so great that the pulleys of largest diameter on the line shaft were being disrupted by centrifugal force, and it is probable that the one driving the dynamos being slightly distorted by regular strain was the first one to go and that the others of same diameter on the line shaft followed in succession. The acceleration of speed once started could not be controlled by the governor belt, so the speed increased until the main fly-wheel was disrupted by centrifugal force, breaking the jack pulley, throwing down the roof of the building and cutting a gap in the roof and sides as shown in the photographs.

The plaintiffs claimed that if the speed of the alternator and exciter increased, the lamps would have been brighter, but evidently the men would not have noticed this if occupied with the fire. They also claimed that since the rim speed of the armatures was greater than that of the pulleys they should have been disrupted first, which was answered by the statement that the materials of the armatures were of higher tensile strength. In fact, the globular shape of the armatures of the Thomson-Houston arc light machines is well adapted to prevent any injury to the winding by centrifugal force, and the wrought iron cores of the spools in the alternator were evidently able to resist much more speed than any cast iron construction. Tests were made by the plaintiffs to find if a governor like that on this engine would regulate with one ball in use. The sleeve lifted by a governor of this size was quite heavy, so it was found that the speed of engine under such circumstances would have been increased to about 118 revolutions per minute, but even this was well within the safe limit even of the pulleys with the most rapid rim speeds.

The speaker made calculations to determine the speed at which the engine and several pulleys would be disrupted by centrifugal force. The normal speed of the rim of a fly-wheel at the diameter of the approximate radius of gyration was 4,715 feet or $\frac{9}{10}$ of a mile per minute. The rim speed of the jack pulley must therefore have been substantially the same, or a trifle less on account of slip, and the rim speed of the 6-foot pulleys on shaft operating the dynamos as well as the rim speed of the pulleys of the dynamos themselves have been about 50 per cent. greater than that of the fly-wheel. From the formula above referred to it was calculated that for a tensile strength of 10,000 pounds per square inch the fly-wheel should have been disrupted at 310¼ revolutions per minute, or, roughly, four times the normal speed. The 6-foot pulleys on the jack shaft should, however, have been disrupted when the engine was running at a speed of 207 revolutions per minute. In order to ascertain approximately the time it would require for an engine under these conditions to run to destruction in case the governor belt were entirely disabled, it was assumed that even with the increased draft on steam pipe, due to running away, a mean pressure of 48 pounds would be obtained, referred to the large cylinder. By "referred" we mean simply that the mean pressure in the small cylinder, divided by the ratio of the area of the two cylinders, is added to the actual pressure in the large cylinder. This mean pressure was sufficient to give 900 horse power at normal speed, and of course the power increased with the speed. It was, however, considered that 13.5 pounds mean pressure out of the 48 were required until the first pulley broke to operate the dynamos and shafting, this pressure being sufficient to produce 253 horse power at normal speed, which is probably a liberal allowance. The mean pressure of 48 pounds is also well within limits, at least for the initial increase of speed, so the time stated hereafter as required to destroy the wheels is probably somewhat greater than would be the case in practice. To ascertain such time it was considered that not only the fly-wheel but every pulley connected therewith, as well as the armatures of the dynamos, really formed fly-wheels which would require force either to accelerate or retard their velocity. To ascertain the effect on the result, the revolving weights of each were ascertained or estimated and multiplied by the ratio of the speed of same to that of the fly-wheel. The sum of those quantities showed the additional weight which it would require in the fly-wheel rim to produce the same result. It was found that the aggregate result was the same as if 10,120 pounds had been added to the fly-wheel rim, making it weigh practically 48,000 pounds instead of 38,000.

On this basis it was calculated that it would require 45 seconds for the engine to increase its speed from 76 revolutions to 207 revolutions, when, on the basis of 10,000 tensile strength, the pulleys on the line shaft should have been disrupted, and as the disruption of such pulleys would have reduced the load on the engine, with the exception of friction, it would only have required 27 seconds, or in round numbers 1½ minutes from the beginning to raise the speed to 310¼ revolutions per minute and disrupt the fly-wheel. There was testimony in the case to the effect that the engineer on watch confessed to his brother engineer that when the fire in the tower was discovered, he pulled the plugs cutting out the arc lights and thus released the load on the dynamos. With this state of facts the load on the engine would have been released earlier and the time required to run to destruction have been diminished. If, however, the governor belt was not broken, but simply slack, so that it took care of changes of load slowly, the acceleration could have progressed at a much less rapid rate.

From what has been stated it will be seen that the combined mechanical and electrical conditions involved in an accident to an electric light plant involve even greater refinements and complications in tracing cause and effect than has heretofore been the case with simple mechanical questions. It will also be observed that a very important question of principle arises in relation to damages occurring in connection with a fire, but not actually caused by the action of the fire itself. It has become necessary in many of the States by law and judicial decisions to exclude what are called "consequential damages," particularly in relation to public works, and this was founded on precedents long established in the older countries. For instance, under the common law a man in digging on his own land was not responsible for damages to a building on adjoining property. It is well understood that a man who fails to pay a debt is only liable for the amount of the debt and interest, although his delay may have caused failures which injured many other persons. So, also, in case of accident, or in fact of any injurious change of condition, there is always a direct result followed by others more or less indirect also in the nature of damage. The indirect results are so far reaching, a damage to one causing more or less injury to another, that litigation would never cease unless some legal estoppel were put upon it, as has been done in relation to many kinds of transactions. Evidently, occurrences of a kind like that in the electric light station will have the effect of causing some such limitation in regard to insurance. If a fire which caused a direct damage of only $100 by fire, and immediate injury to only a few hundred dollars of fixtures in the neighborhood, can in addition be charged with the cost of injuries caused by a runaway engine, there might conditions arise where still further consequential damages would go on almost without end. For instance, questions of personal injury might be involved from many people struck by flying fragments, or a large fragment might knock down a drawbridge in the vicinity and wreck a train of cars, or such a fragment might strike a vessel loaded with explosives and cause a gunpowder or dynamite explosion which would wreck the whole neighborhood, and if such explosives were required for use by a then friendly government and that government failed to prevail in an impending war for a lack of such material, the one hundred dollar fire in the beginning might cause international complications and result in a general war. Somewhere in the progress from first cause to final effect the law of consequential damages should, and will sooner or later, be made to apply, and special policies will be written when accidents to machinery are to be included. Without anticipating what will be done, it would seem natural to limit the damage at a point where the carelessness of the employees or of the insured, by defects in mechanism or material, caused the increased damage.

In the case under discussion the Judge ruled, for the purpose of the trial, that even if the pulley was defective which it was claimed broke first, so that it broke with less strain than such pulleys should, still the insurance companies would be liable. Evidently if this were the case any slight accident, such as short circuiting the electric lights outside but near the station, or the dropping of a tool in some part of the machinery, might without fire have caused the other more important damages. It therefore appears equitable that at such a break in the chain as this, a limitation of damage arising from fire should be made, on the general principles that have made it necessary to provide limitations in other cases, and also on a principle like that of contributary negligence in case of personal injury, whereby it would be provided that whenever the insured were themselves also at fault, either through the action of their employees or by the use of defective machinery, which would be liable to cause such accident without fire, the damages from *fire* should be limited at that point. Who knows but what the courts may finally hold that this is a fair interpretation of the law as it stands?"

"THE MOST VALUABLE AND THE MOST SCIENTIFIC."

A WELL-KNOWN professor of physics and chemistry in one of the State Universities writes us: "I have recently become a regular reader of THE ELECTRICAL ENGINEER. I consider it the most valuable electrical periodical which I receive, and I take all the leading ones. That which leads me to this opinion is that it is the most scientific of the publications referred to."

ON THE LAW OF HYSTERESIS.—IV.

BY CHARLES PROTEUS STEINMETZ.

The second set of tests, which is specially interesting on account of the very low magnetizations reached therein, is given in the following:

TABLE VI.

Frequency, $N = 170$; $\eta = .00421$. $\varepsilon = .2083 \times 10^{-6}$

B.	H_1	H_2	H. calc.	H. obs.	$H. - H.$ calc. obs.	= %
85	5.2	3	5.5	5.6	− .1	− 1.8
182	17.3	1.3	18.6	16.9	+ 1.7	+ 10.0
211	22.0	1.7	23.7	23.5	+ .2	+ .9
560	105	11	116	122	− 6	− 5.0
670	140	15	155	146	+ 9	+ 6.1
685	145	16	161	157	+ 4	+ 2.6
775	176	21	197	202	− 5	− 2.4
800	186	22	208	200	+ 8	+ 4.0
1000	265	35	300	300	……	……
1070	296	41	337	353	− 16	− 4.6
1130	322	47	369	386	− 17	− 4.3
1250	379	56	435	430	+ 5	+ 1.2
1380	445	69	514	514	− 26	− 4.7
2200	940	170	1110	1130	− 20	− 1.8
2420	1090	208	1298	1268	+ 30	+ 2.4
					+ 38 − 90	+ 27.2 − 21.6
					± 10	± 3.4

Therefore we get the formula for the loss in the iron,

$$H = .00421\, B^{1.6} + .2083 \times 10^{-6}\, N B^2$$

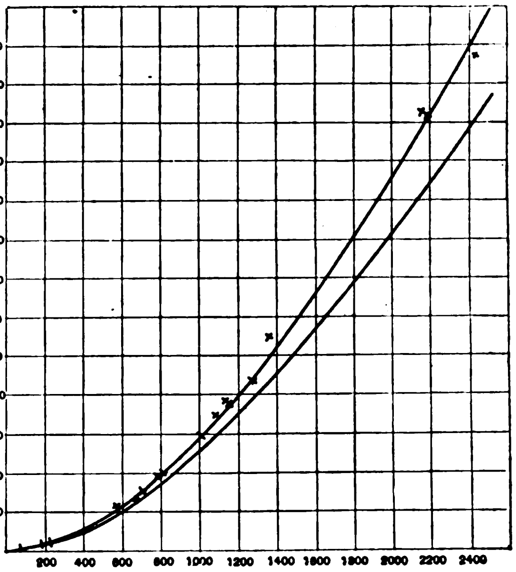


FIG. 3.

In Fig. 3 are shown,

1. The curve of true hysteretic loss, $H_1 = .00421\, B^{1.6}$

2. The curve of the whole loss in the iron, $H = H_1 + H_2$; with the observed values marked by crosses +.

Especially interesting are these two sets of readings in so far as they cover quite a different range of magnetization as the tests in I. to III. In I. to III. the tests cover the range from 1,790 to 19,340 lines of magnetic force per cm.,^{2} that is, for medium magnetization up to high saturation, while the tests in IV. cover the range from 85 to 2,600 lines per cm.^{2}, that is, from medium down to very low magnetization.

The law is found exactly the same,

$$H = \eta\, B^{1.6} + \varepsilon\, N B^2$$

and herewith proved for the full range from 85 lines per cm.^{2} up to 19,340 lines, a ratio from 1 ÷ 230.

This seems not to agree with Ewing's theory of the molecular magnets. According to this theory, for very small magnetization the hysteresis should be expected to disappear, or almost disappear, and the cycle be reversible. Then for medium magnetization, where the chains of molecular magnets break up and rearrange, hysteresis should increase very rapidly, and slowly again for saturation. Nothing of this is the case, but hysteresis seems to follow the same law over the whole range of magnetization, and is certainly not zero for even such a low magnetization as 85 lines per cm^2.

Magnetometer Tests.—The method used in the foregoing has the great advantage that: 1. It allows the taking of a greater number of readings, over a wide range of magnetization, in a short time, by mere simultaneous instrument readings, and thereby reduces the probable error by increasing the number of observations. 2. It allows the use of electro-dynamometers, as the most reliable electric measuring instruments.

3. It deals with large amounts of energy, counting by watts or even hundreds of watts, whereby much greater accuracy can be reached than by the ballistic galvanometer.

4. It measures the hysteresis under the influence of an harmonically, and not suddenly, varying M. M. F., that is, under the same conditions, where it becomes of importance for practical engineering.

But it has the great disadvantage that it can be used only for testing sheet-iron or other thoroughly laminated iron, where eddies are either inappreciable or can be calculated also. For testing solid iron and steel pieces, this method cannot be used, because of the tremendous amount of eddies which would flow in a solid piece of iron. To determine the hysteretic loss of energy in steel and cast-iron the Eickemeyer differential magnetometer was used. Complete description of this instrument and its use is to be found in THE ELECTRICAL ENGINEER, March 25, 1891.

To get absolute values, the instrument has been calibrated in the following way: In the front and in the back the magnetic circuit of the instrument was closed by 4 cm.^{2} of Norway iron. Then another piece of iron, and of any desired size, was added in the front. This piece, y, carrying some magnetism also, disturbed the equilibrium. Then through a coil of exactly 110 turns, surrounding this piece y, an electric current i was sent and regulated so that equilibrium was restored. In this case no magnetism passed through y, or in other words, the M. M. F. of the current *i. e.*, 110 ampere turns is equal to the differences of magnetic potential between the pole-faces of the instrument. In this way, for any strength of current in the main coil C of the magnetometer, the difference of magnetic potential produced thereby between the pole faces of the instrument, was determined and plotted in a curve, for convenience in ampere turns per cm. length.

Now, the Norway iron standard was compared on the magnetometer with sheet-iron, of which, from tests with low frequency alternating currents, the magnetization corresponding to any M. M. F. was known, and therefrom was derived the magnetic characteristic of the Norway iron standard, and plotted in a curve also.

In the way explained before, the iron sample that was to be determined, was balanced in the magnetometer by Norway iron, thereby giving its susceptibility in per cent. of that of the Norway iron standard, the magnetometer current read, from the curves taking the M. M. F. corresponding thereto—denoted by F—and the magnetization of the Norway iron, corresponding to this M. M. F., F, and from the determined per centage of susceptibility of the examined sample, the magnetization B of this sample corresponding to the M. M. F. F.

With this instrument a number of magnetic cycles of different samples of steel and cast-iron were determined. First, a powerful alternating current was sent through the magnetometer and around all the iron pieces used, to destroy any trace of permanent or remanent magnetism. Then the examined sample was laid against the front, the standard against the back of the magnetometer, balanced, and a larger number of magnetic cycles completed between given limits, for instance, $+ 95$ and $- 95$ ampere turns M. M. F. per cm. length. Then readings were taken from maximum M. M. F. $+ 95$ down to zero, and again up to the maximum $- 95$, down over zero and up to $+ 95$, thereby completing a whole magnetic cycle, and then of a second magnetic cycle, a few readings were taken as check for the first one. In this way for different M. M. F.'s the curve of hysteresis was found, and by measuring its area the loss by hysteresis determined.

The further calculation was done in a somewhat different way. Generally the number of cycles was not large enough to determine conveniently the exponent by analytical methods. Therefore the law of the 1.6th power, $H = \eta B^{1.6}$, was assumed as true, and for each cycle from the known values of H and B determined the coefficient η.

If for different cycles the values of η agreed, this would prove the assumption, the correctness of the law of 1.6th power, while a disagreement would disprove it. In the following the magnetic cycles are given for a number of samples.

(*To be continued.*)

A PLANT FOR ST. CLAIR, MICH.

MR. SIMON LANGELL, the Mayor of St. Clair, Mich., writes us that the city contemplates putting in a plant. He will be glad to receive data and information on the subject.

Reports of Companies.

ANNUAL REPORT OF THE EDISON GENERAL ELECTRIC CO.

WE give below the full text of the annual report of the Board of Trustees to the stockholders of the Edison General Electric Co., presented on February 10, 1892:

The submission to you of this the Third Annual Report of the Board of Trustees has been delayed in consequence of the new general corporation law of the State of New York, which went into effect May 1, 1891, pursuant to the provisions of which the Annual Meeting is held on the 10th day of February, 1892, instead of on the 18th day of January, 1892.

INCREASE OF CAPITAL STOCK.

In the last annual report the statement was made that, owing to the large and rapid increase of the Company's business, it had become necessary to provide for the enlargement of its manufacturing plants and for additional working capital, and that for these purposes your Board had disposed of most of the unissued capital stock of the Company held in the treasury, and had borrowed $2,000,000 through the Sprague Electric Railway and Motor Company, in repayment of which loan the lenders agreed to take a like amount of the stock of this Company. To make corresponding provision, a special meeting of the stockholders was called and held immediately after the annual meeting, at which, in accordance with the recommendation of the Board, the increase of the capital stock from twelve millions to fifteen millions was authorized by a unanimous vote.

Two millions of the increase were used in liquidation of the loan to the Sprague Company, and the remaining one million was left unissued in the treasury to meet future requirements.

The net earnings in the fiscal year 1889-90 having exceeded eight per cent. on the total stock of the Company, the trust existing under three certain agreements with the Farmers' Loan & Trust Company (whereby dividends had been temporarily deferred on some $2,482,700 of the Company's stock), reached its termination. The stockholders at the last annual meeting were therefore asked to authorize the payment of the regular dividends on the deferred stock (so called), and such other action as was required for the exchange of the trust certificates for the regular dividend-paying stock. The recommendations of the Board in these respects were also unanimously approved.

In consequence of the steadily-growing financial requirements for current business, as more fully explained in another place, the Board deemed it prudent to dispose of the remaining $1,000,000 of stock in the treasury, so that of the $15,000,000 authorized $14,964,900 is now outstanding, the difference being reserved for the retirement of the outstanding Edison Electric Light Company's stock, unless the Board should decide to dispose of the same in some other manner.

WORKING OF THE NEW DISTRICT ORGANIZATION.

Reference was made in the last annual report to the new working organization, which went into effect on August 1, 1890. Under it, the United States and Canada were divided into eight geographical districts, each in charge of a head official entitled "District Manager," instructed by, and reporting and directly responsible to, the Executive Officers of the Company. The organization has now been tested by an experience of fifteen months, and the Board feel warranted in saying that the practical results from it have been fully up to expectations. The change has contributed not only to the greater efficiency of the service in every way, but directly and indirectly to the growth and stability of our business, and to the prompt execution of orders. The new system has entirely superseded the old one of securing business mainly by the payment of commissions, and all officers and employees of the Company are now under salaries. The Company was fortunate in securing able, faithful and experienced men for the management of all the districts. The first of a series of conferences, intended to be held annually, of all the district managers with the chief executive officers of the Company, was recently held in New York.

SHOWINGS OF THE GENERAL BALANCE SHEET.

In order to enable the stockholders readily to compare the general balance sheet for the past year with that of the previous one, the figures for both have been printed in parallel columns, together with the differences they show.

The footings of the general balance show $21,507,284.42 in 1890-91, against $17,958,852.81 in 1889-90, being an increase of $3,548,431.61. The increase of assets includes additions to "Manufacturing Plants" of $1,262,410.91, to "Patents" $26,604.14, to "Real Estate" (completion of main office building in New York) $136,624.81, to "Capital Stock of Edison Electric Light Company" $12,693.32, to "Stocks and Bonds" $502,846.65, to "Cash" $348,274.53, to "Bills and Accounts Receivable" $261,663.36, to "Work in Progress" and "Materials and Supplies" $771,963.75. The balance also comprises two new items, "Laboratory Account," $66,815.72, being the share borne by the Company towards inventive work completed or in progress in Mr. Edison's Laboratory under the new contract with him, referred to in the last annual report, and "General Liquidation Account," $158,534.42, representing unliquidated items, making part of cost of acquisition of various Sub-Companies and stock of Sprague Company.

Included in the liabilities is an allowance for "Depreciation of Manufacturing Plants." This account shows that $271,592.29 had been taken out before the year's profits were figured. The total amount now carried in this account is slightly over ten per cent. of the entire cost of this Company of the manufacturing plants, notwithstanding the fact that the amount of cash expended to enlarge those plants during the past two fiscal years is $2,211,685.61, and on this new investment the actual depreciation so far is little or nothing. "Mortgages on Real Estate" ($200,000 of which is on the main office building in New York) shows an increase of $65,000, Capital Stock" $1,115,500, "Bills Payable" $1,709,238.75, "Accounts Payable" $44,350.59. The surplus of "Profit and Loss" carried forward, viz., $1,260,067.11 (after payment of eight per cent. dividends on capital stock), is larger by $64,513.98 than that brought over from the preceding year.

The increase of $1,262,410.91 in "Manufacturing Plants" represents investments in lands, buildings, machinery, tools and miscellaneous equipment, which were rendered necessary by the growth of business, and this expenditure has secured to the several works an enlarged capacity and technical efficiency. Your Board are happy to say that with the large expenditures during the past year no considerable outlay in the same direction is likely to be required for some time, unless there should be an exceptional growth in electrical business throughout the country.

The "Bills and Accounts Payable" represent a total of $4,201,417.75, against $2,447,828.41 in 1889–90, making an increase (as already stated) of $1,753,589.34, or (deducting the $348.274.53 excess in "Cash on Hand" at the close of the past year) of $1,405,314.81. The reasons for this large increase in the Company's liabilities are readily seen. In the first place, the peculiar character of the manufacturing and contracting business calls for the employment of more cash or working capital in proportion to production than in perhaps any other existing industry. The continuous purchases of expensive raw material consumed in large quantities. such as copper, require the constant use of a great deal of ready money. The rapid progress of the technical art, too, involves the necessity of devising and manufacturing new articles, the marketing of which is sometimes slow at first. In the second place, the system of District Agencies amounts to nothing less than the opening of as many wholesale stores, fully supplied with stocks of the Company's manufactures, from large motors and dynamos down to the smallest incandescent lamp fittings, in order to save time and expense in filling local orders. To this cause the increase of $849,585.63 in "Materials and Supplies" on hand over 1889–90 is directly and specifically due. Lastly, as has been shown, the addition to the items "Manufacturing Plants," "Real Estate," "Stocks and Bonds" and Laboratory Account," amounting together to $1,968,698.09, represent a corresponding absorption of working capital, thereby necessitating the raising of additional capital by increasing the stock or the use of the Company's credit as a substitute. In order to keep its use within prudent limits, the $1,000.000 of treasury stock was disposed of as stated, and it is the opinion of your Board that an issue of another $1,000,000 of stock should be made at an early date.

The properties of the Company in fixed form, *i. e.*, in manufacturing plants and real estate, having been increased by $1,399,035.72 during the year, now represent a cost on the Company's books of $5,748,548.70, less $537,663.56 standing to the credit of "Depreciation Account," Besides this, at the close of the year, the Company owned (in addition to patents) the stocks of controlled companies and other stocks and bonds (including the stock of the Edison Electric Light Company) appearing in the balance at the aggregate nominal value of $5,936,668.60, and had in cash on hand, bills and accounts receivable, work in progress (booked at cost), and materials and supplies (also at cost), no less than $9,273,868.86, and all this against bills and accounts payable of $4,201,417.75. These figures show the intrinsic strength of the Company.

THE BUSINESS OF THE YEAR—PROFITS.

Summarily stated, the gross business of the General Company amounted to $10,942,640.34, on which the profits, including the $271,592.29 written off against the cost of the manufacturing plants, were, according to the books of the Company, $1,666,535.72. To this amount must be added the General Receipts at the Main Office, $83,013.99, making a total of net earnings of $1,749,549.71.

Deducting from the above net receipts of the Edison General Electric Company (exclusive of those of the Edison Electric Light Company) the sum of $271.592.29 charged off on manufacturing plants, and $286,477.59 charged off against "Liquidation," "Materials in Stock" and "Experimental Account," we have $1,191,479.83 as the net result of the year from the business of the Edison General Electric Company alone. Adding $1,100,432.48 surplus profits carried over from the preceding year, we have a total of $2,291,912.31 profits available for distribution. After paying $1,031,845.20 in dividends, $1,260,067.11 is carried forward into the new year.

As set forth elsewhere, the Edison Electric Light Company has received during the year $631,672 in bonds and stocks, as license fees from licensee companies, worth, at a moderate valuation, say, $500,000, of which the Edison General Electric Company (through its holdings of Light Co. stock) is entitled to over ninety-nine per cent., or say $495,000, which is equal to 3.16⅔ per cent. additional on the capital stock.

The year's profits were not so large as those for 1889-90. This is largely due to the considerable decline in the prices obtained for the product of the manufacturing establishments owing to increased competition and other causes. Another general cause of the diminished profits was the depression prevailing in all classes of business during the greater part of the year, and the unwillingness of capital to engage either in old or in new enterprises. This was especially noticeable in the business of large central stations, of which fewer were organized than usual, while those previously organized proceeded more cautiously than usual in enlarging their plants. The general condition of the country imposed great caution upon the management. The General Company could have done a much larger business if it had been willing to accept securities in payment for orders; but in view of the commercial and industrial situation at large, a strict rule was adopted of declining all such, and doing business exclusively on a cash or short credit basis. In order to effect settlements of a number of contracts taken prior to the present organization, securities were, however, accepted. This accounts for almost the whole of the increase of $502,846.65 in "Sundry Stocks and Bonds." The result of the general policy pursued proved at once the wisdom of the course adopted, and the remarkably safe and solid character of the Company's business. For, although the gross sales reached nearly $11,000,000, the bills and accounts receivable increased only $261,663.36 during the year, showing the promptness with which collections were made.

THE EDISON ELECTRIC LIGHT COMPANY.

The changes in the condition of this Company are fully set forth in the accompanying comparative Balance Sheet. As will be seen, its relations to the local companies licensed by it have again yielded very gratifying returns. Much progress has been made by this Company during the year toward sustaining the position to which the ownership of the Edison patents entitles it, namely, the exclusive ownership of the fundamental patents relating to the business of incandescent electric lighting.

On July 14th last, Judge Wallace, in the United States Circuit Court, at New York City, filed a decision in the test suit on the principal lamp patent, sustaining that patent as covering broadly all existing incandescent lamps. The case had been most stubbornly contested for several years by the infringers, and, as was to be expected, an appeal was taken, which will come up for early hearing. A favorable decision by the Appellate Court, which is confidently expected by our counsel, will give the Company the control of the manufacture and sale of the incandescent electric lamp.

Satisfactory advance has also been made in the suits prosecuted to establish the right of this Company to the only system of electrical distribution and regulation suitable for incandescent lighting upon an extensive scale. Among them are the test suit upon the feeder patent and that upon the three-wire patent, in which a great mass of testimony has been taken during the past year. These cases will be ready for argument during the coming year.

A patent has lately been granted to Mr. Edison on the principle underlying the high-tension transformer system, and suit is about to be brought upon that patent to establish this Company's right to the transformer system, as well as to the direct-current system.

This Company's patents upon electric railways (including the Sprague patents), which are universally infringed, have also been, during the past year, made the basis of suits against competitors, with a view of establishing its rights in the electric railway business.

From the date of its organization in 1878 up to the present time, the Edison Electric Light Company has accumulated all its profits in its treasury. These profits are mainly in valuable stocks of local illuminating companies. Recognizing the justice of a distribution of some part of them, the Directors of the Light Company have, since the close of the fiscal year, declared a dividend of about $1,500,000, par value of these securities.

Over ninety-nine per cent. of them come to this Company as the owner of nearly all the stock of the Light Company.

Reference is made to the subjoined report of the Second Vice-President on the business prospects of the current year.

The thanks of the Board of Trustees and Stockholders are again due to the Officers and Employees for the faithful performance of their duties.

By order of the Board of Trustees,
HENRY VILLARD,
President.

EDISON GENERAL ELECTRIC COMPANY.

Profit and Loss Account, October 31st, 1891.

EXPENSES.		
General expenses..............		$794,788.63
Items now written off :		
Net amount charged off during the current fiscal year against liquidated items, taken over from various sub-companies...........	$148,083.99	
Amount charged off against materials in stock upon taking inventories.........	128,393.60	
Experimental account.......	10,000.00	286,477.59
Dividends declared or paid, including interest on notes payable in stock.................		1,031,845.20
Balance—Surplus carried forward, October 31st, 1891 ...		1,260,067.11
		$3,373,128 53

EARNINGS.		
Profit and Loss — Surplus brought over, October 31st, 1890.	$1,195,553.13	
Less amount chargeable to 1889-90 against liquidated items taken over from various sub-companies.........	95,120.65	$1,100,432.48
Profits from November 1st, 1890, to October 31st, 1891 (not including those of the Edison Electric Light Company)............		2,272,696.05
		$3,378,128.53

E. & O. E.—New York, February 10th, 1892.
J. P. ORD, *Comptroller.*

EDISON GENERAL ELECTRIC COMPANY.

General Balance Sheet, October 31st, 1890, and October 31st, 1891.

ASSETS.	October 31, 1890.		October 31, 1891.		INCREASES.
Manufacturing plants...............		$4,085,160.70		$5,347,571.61	$1,262,410.91
Patents (on manufacturing processes and articles manufactured).......		296,243.98		322,848.12	26,604.14
Real estate (on Broad St , N. Y. City).		264,352.28		400,977 09	136,624.81
Capital stock of Edison Electric Light Co		4,343,050.13		4,355,748 45	12,698.32
Entire capital stock of Sprague Electric Railway and Motor Co. (representing Sprague patents)..........		680,000.00		680,000.00	
Sundry stocks and bonds (of various local electric illuminating and electric street railway companies received in part payment for work done).............		398,078.50		900,925 15	502,846.65
Cash....................................	$434,582.75		$782,857.28		
Bills receivable	983,805.69		1,092,508.00		
Accounts receivable.................	2,200,675.15	3,619,063.59	2,353,636.20	4,229,001.48	609,937.89
Work in progress (cost to date of all labor, material, etc., on uncompleted installations)	1,266,173.85		1,188,551.97		
Materials and supplies (on hand and in process of manufacture)	3,006,729.78	4 272,903.63	3,856,315.41	5,044,867 38	771,963.75
Laboratory account...				66,815.72	66,815.72
General liquidation account (representing unliquidated items, making part of cost of acquisition of sub-companies and stock of Sprague Co.)				158,534.42	158,534.42
		$17,958,852 81		21,507,284.42	$3,548,431.61

E. & O. E.—New York, February 10th, 1892.
J. P. ORD, *Comptroller.*

EDISON GENERAL ELECTRIC COMPANY.

General Balance Sheet, October 31st, 1890, and October 31st, 1891.

LIABILITIES.	October 31, 1890.		October 31, 1891.		INCREASES.
Allowance for depreciation...........		$266,071.27		$537,663.56	$271,592.29
Mortgages on real estate.............		200,000.00		265,000.00	65,000.00
Capital stock........................	$11,849,400.00		$18,964,900.00		
Notes payable in stock at par.........	2,000 000.00	13,849,400.00	1,000 000.00	14,964,900 00	1,115,500.00
Bills payable..........	1,776,752.48		3,485,991.23		
Accounts payable..................	671,075 93	2,447,828.41	715,426.52	4,201,417.75	1,753,589.34
Dividends declared and unpaid........				278,236.00	278,236.00
Profit and loss, surplus carried forward (in excess of dividends declared and paid)...........		1,195,553.18		1,260,067.11	64,518.93
		$17,958,852.81		$21,507,284.42	$3,548,431.61

E. & O. E.—New York, February 10th, 1892.
J. P. ORD, *Comptroller.*

This is supplemented by a report from Mr. Samuel Insull, second vice-president, on the prospective business of the Company. It states, among other things, that the Edison Co. in San Francisco is to install a plant of 20,000 lights; that the Chicago Edison Co. will spend $2,000,000 within the 'next five years, and most of the sum immediately; that the companies in Boston and New York are enlarging; and that heavy work is in hand for Milwaukee and Cincinnati. The "cash" stations and isolated plants promise to run about 500 000 lights for the year; and the Company already has on its books orders for 2,000 arc lights and corresponding dynamo capacity. Other departments of the business were in equally good shape.

At the annual meeting of the stockholders the following trustees were elected for the ensuing year: C. H. Coster, Thomas A. Edison, J. H. Herrick, Samuel Insull, Edward H. Johnson, A. Marcus, Carl Schurz, Francis S. Smithers, Samuel Spencer, Henry Villard, J. Hood Wright. The only change from the former board is the election of Samuel Spencer (of Drexel, Morgan & Co.) in place of James B. Williams. The old officers have since been re-elected, but Mr. Villard has handed in his resignation, to take effect in due course.

Society and Club Notes.

DES MOINES ELECTRIC CLUB.

THE Des Moines Electric Club has organized, adopted a constitution and elected the following officers: President, Charles C. Buckley; vice-presidents, L. L. Barge and H. Wheaton; secretary, W. L. Youngerman; treasurer, Jesse O. Wells; managers, H. B. Day, C. Berry, J. A. Innes and C. A. Felkee. It is intended to provide an assembly room where members and any others interested may meet and listen to papers or talks concerning electricity and discuss questions arising in this branch of science. Rooms have been secured and the time of the first meeting for such a purpose will be duly announced.

CHICAGO ARCHITECTURAL SKETCH CLUB.

THE CHICAGO ARCHITECTURAL SKETCH CLUB, at its meeting, February 8th, listened to a talk by Mr. Chas. G. Armstrong on "Some Electrical Experiments." In his capacity of electrical expert, Mr. Armstrong is already well known to architects and this opportunity of impressing them with some whys and wherefores of electrical plants may have helped them to appreciate the need of the intelligent and independent supervision of the electrical work in buildings.

The majority of those present—and they filled the neat hall—had been repeatedly confused by the variety of opinions and arguments advanced by non-electrical people, but were soon led along the clearly defined line of thought suggested by the series of experiments. Illustrations of the relations between magnetic and electric circuits, and of those expressed by Ohm's law, paved the way for a consideration of wires as conductors. After showing the need of cut-out devices and their operation, Mr. Armstrong's experiments proved the relations between life, light and efficiency in the incandescent lamp—a point rarely understood by architects and contractors. Other touches on insulations and methods of testing them, on arc lamps and their proper sphere of usefulness and on the comparisons between electric lights and other means of illumination, followed each other in the course of an off-hand talk, which closed with a note on the coming electric lamps.

The discussion brought out a number of points which are commonly misunderstood by the layman, and the interest shown by the members of the Sketch Club would seem to promise a better understanding of the work to be done by the supervising electrical engineer.

PRESIDENT CHANDLER'S REMINISCENCES OF LINCOLN.

The anniversary of Lincoln's birthday was celebrated at the Electric Club, on Friday, February 12, and the club members and invited guests were entertained by reminiscences of the great President by Mr. A. B. Chandler, president of the Postal Telegraph Cable Company. Mr. Chandler was a United States military telegrapher at Washington during the Civil War, and for years was thus in the closest confidential association with Mr. Lincoln. Among the many interesting things told by Mr. Chandler was the following:

"The second time I remember Mr. Lincoln speaking to me was very early one morning, perhaps 6 o'clock, soon after I went to Washington. I had been on duty all night. He left the office as late as 10 or 11 o'clock the night before, but so anxious was he for news from the armies that he often came over from the White House soon after daylight to see the dispatches which had come in during the night. He happened to find me on this morning in just the same position (writing at the desk that we then called Colonel Stager's) in which he had seen me the night before, and as he came in he said: 'Have you been sitting right there all night?'

"Then he read over the new messages, carbon copies of which we made on letter-size tissue paper and put, without folding, in a little drawer in what we called the cipher desk. The contents of this drawer were for his special information. The messages were placed in it in the order of their reception, and he was quite careful to keep them so. It was his habit to read from the top down, and when he came to those which he had already read, with a smile he said: 'Well, I guess I have got down to the raisins.'

"As I seemed in doubt as to what that might mean, he explained that a little girl, having eaten improperly, both in quantity and quality, beginning with a lot of raisins, was made quite ill, and could only find relief in the process a sick stomach is apt to compel. After an exhausting siege of throwing up, she gave an exclamation of satisfaction that the end of her trouble was near, for she had 'got down to the raisins.' I suppose that I have heard Mr. Lincoln use the expression twenty times at least, when he had finished reading the new messages in his drawer, and had reached those which he had read before."

Mr. Chandler told a great many other stories about Lincoln never heard before, and wound up a most intensely interesting lecture by a strong appeal for justice to Stanton, Mr. Lincoln's Secretary of War. Aside from its historical value, the whole address by Mr. Chandler had a literary charm of delivery and diction that pleased the members immensely.

Mr. Chandler was followed by Mr. Holloway, president of the Engineers' Club, who spoke of what he saw at Lincoln's nomination; and by Gen'l O'Beirne, who was with Lincoln in his few hours of life after the assassination. The lecture and speeches were interspersed by war songs given by the Brunswick Quartette; and at the speakers' end of the parlor a bust of Lincoln stood, draped with the Stars and Stripes.

During the evening, before the lecture, Steward Reynolds served one of the best table d'hote dinners that the club has ever enjoyed.

SOUTHERN BERKSHIRE SOCIETY.

The fifth annual meeting and dinner of the Southern Berkshire Society at Clark's on Twenty-third street, February 11th was attended by 80 members and guests. This society is composed of natives of Berkshire county and their families residing in this city and vicinity. Among the electrical representatives present were F. L. and R. W. Pope, Richard S. Brown and Chas. B. Williams, with their wives. Ralph W. Pope, secretary of the American Institute of Electrical Engineers, was elected president for the ensuing year.

THE BUFFALO N. E. L. A. CONVENTION.

The following is the official programme of the Convention:

Tuesday, February 23, 1892.

Meeting of the Executive Committee, at 9 a. m. Parlor Iroquois Hotel; morning meeting, 10.30 a. m., at Library Building. Address of Welcome by Hon. Charles F. Bishop, Mayor of Buffalo. Address of President Huntley. Report of Committee on Underground Conduits and Conductors, M. J. Francisco, Chairman.

AFTERNOON SESSION, AT 2 P. M.

Report on Safe Wiring, M. D. Law, Chairman. Report of Committee World's Columbian Fair, B. F. Sunny, Chairman. Paper by Richard Hammond, How to Fire a Steam Boiler.

EVENING SESSION, AT 8 P. M.

Paper by Carl Hering, Transmission of Power. Discussion by William Stanley, Jr., L. B. Stillwell, H. Ward Leonard, Elihu Thomson, and others.

Wednesday, February 24.

MORNING SESSION, AT 10 A. M.

Paper by D. Ashworth—The Allied Powers. Paper by Wm. Stanley, Jr.—The Alternating Current Motor. Paper by Erastus Wiman—Electric Lighting from a Financial Standpoint.

AFTERNOON SESSION, AT 2.30 P. M.

Paper by M. C. Sullivan—Switchboards, Their Safety and Operation. Paper by Chas. A. Schieren—From the Tannery to the Dynamo. Paper by Allen R. Foote—Municipal Franchises for Quasi-Public Corporations.

Thursday, February 25.

MORNING SESSION, AT 10 A. M.

Paper by E. F. Peck—Overhead Construction. Paper by E. A. Leslie—Operation of High-Tension Currents Underground. Paper by J. B. Craven—Underground Construction of Buffalo Railway Co.

AFTERNOON SESSION, AT 2.30 P. M.

Paper by L. B. Stillwell—Report of Secretary and Treasurer. Report from Executive Committee. Election of Officers.

A CHICAGO INSTITUTE OF TECHNOLOGY.[1]

"The Necessity and Present Opportunity for the Establishment of a Technological Institution with Physical Laboratory and Museum of Mechanical Arts in Chicago," was the title of a paper of considerable length read by Mr. Francis W. Parker before the Chicago Electric Club on the evening of February 3, in which patriotic citizens were called upon to repay the debt Chicago owes the profession of engineering, by founding an institution of technical education that should be unsurpassed by anything of the kind now in existence. The gist of Mr. Parker's address is summed up in the following extracts:

There is a necessity for technological education in Chicago. First, because Chicago is so entirely the product of engineering; second, because she is so profoundly interested in and her future is so largely dependent upon engineering; third, because her wealth is so abundant and her citizens are so liberal; fourth, because all other kinds of education are so abundantly provided for; fifth, because this is the highest and best form of education; and sixth, because the coming of the World's Fair necessarily provides both the occasion and in a large degree the means for the establishment of such an institution.

Other cities have grown to greatness—Chicago has been built and engineered to greatness. They have increased by addition. Chicago by multiplication. Chicago as the creation of engineering will be the chief exhibit at the World's Fair, and yet how that exhibit will be marred by the absence of any means by which men may be educated in the arts whereby the city has been created. The first question asked by an intelligent stranger who has beheld our material advancement will be, "Where is your school of technology?" and our answer must be, "We have none." Every one of the great engineering works either completed or actively agitated in 1890 and 1891 was of direct and immediate interest to Chicago, except the Croton aqueduct, and of seven great bridges undertaken five were directly tributary to Chicago. The remainder of the paper was devoted to Chicago's greatness in commerce, theology, music, the fine arts, and, in fact, in all directions except that of technical education, and closed with the following words:

"All honor to those whose generosity has given us our universities, libraries, Art Institute, World's Fair and other institutions, but still more honor to those who will round out the work by creating at Chicago the world's greatest school of technology and engineering."

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[1] Abstract of a paper read by Francis W. Parker before the Chicago Electric Club, Feb. 3, 1892.

Letters to the Editor.

THE MORSE-VAIL TELEGRAPH CONTROVERSY.

IN your issue of February 10, there appeared a communication, signed, "Park Benjamin," which, it seems to me fair to presume, was written in the interest of those who would stifle all discussion of the claims of my father, Alfred Vail, to the invention of the electric telegraph, generally styled the "Morse System." I should be glad to learn as to the authority of Mr. Benjamin, by means of which he so confidently interposes "a respectful but *firm* objection to the trial, at the present time, of the Morse-Vail telegraph controversy in the columns of the *Evening Post*," on behalf of "*all the readers* of electrical matter in the daily press."

I am happy to state that my experience does not warrant my acceptance of Mr. Benjamin's status (as assumed by him in his *self-appointed* position), for I find a universal interest on the part of the public in learning that, to Alfred Vail, and *not* to Morse, is the world indebted for the great invention that has brought the ends of the earth together.

I also observe, I am happy to state, an equally universal expression of the desire and hope that the name of Alfred Vail, will receive the full credit due him for the great part he had in the invention. I have before this expressed a desire to be informed, *what it was, of the electric telegraph* (as it is to-day, and as it has been since it became a practical success), *that Morse did invent;* but I am, to this date, without the desired information, and I shall, in all probability, remain so, for, as the telegraph consists of a wire, a battery, a magnet, a receiver, a key, and an alphabet, *none of which were invented by Morse,* he evidently was not "in it"!

Mr. Franklin L. Pope, has thus written: "From 1837 to 1844, the telegraph was a combination of the inventions of Morse, Henry and Vail, but, as we have seen, *the elements contributed by Morse, have gradually fallen into desuetude, so that the essential telegraph of to-day, and the universal telegraph of the future, comprises solely the work of Henry and Vail.* The grandeur of Vail's conception of an alphabetical code, based upon the elements of time and space, has never met with the appreciation which it deserves."

If I grasp the argument of Mr. Benjamin (in support of which he draws so extensively upon his profound acquaintance with electrical controversy), it is, that the importance of an invention, and the justice involved in placing its true inventor before the world, is only to be gauged by the relative *numerical position* it has, *by date,* in the line of undecided cases, which is neither good law nor good logic.

I know of no power by which Mr. Benjamin can be required to read any matter, telegraphic or otherwise, that may appear in the daily press, and I am therefore compelled to think that his article was inspired by some other feeling than that of a public philanthropist.

STEPHEN VAIL.

NEW YORK CITY.

THE SERVICES OF GILBERT AS REGARDED BY MR. THOMAS D. LOCKWOOD.

I HAVE respectfully read the rescript handed down by Mr. Thomas D. Lockwood, in which he approves of THE ELECTRICAL ENGINEER. That is good. He also "coincides" with me in my sentiments about Gilbert, which is not English, but still good too. And he says that "I (meaning Mr. Thomas D. Lockwood) have always availed *myself* (still meaning Mr. Thomas D. Lockwood) of opportunities to pay the tribute of full appreciation to the worth of Gilbert's services to electricity;" which is troublesome to parse, but yet, on the whole, the best of all. No more can ox-like Briton trample in the dust that fair repute. Mr. Lockwood is going to preserve it; for now we know that so long as "Practical Information for Telephonists" pursues its exciting career down the eons, there banging and rattling after it and tangling itself up with its hind legs, will always be found *his* (Mr. Thomas D. Lockwood's) "tribute of full appreciation to" etc., etc. Now is Gilbert's reputation made forever!

It is interesting to learn from Mr. Lockwood that the translation of "de Magnete," so long promised by the Gilbert Society, does not appear because "the revisers are all busy men who can only devote a small portion of time to that work." To many, that will have all the spice of entire novelty. Perhaps Mr. Lockwood may be shrewdly hinting that *he* has somewhere a corps of overworked British "revisers" torturing their cheese-like and indurated brains over the thing; in which case, somebody ought to remonstrate with him for his cruelty to animals. As a matter of fact, however, the average American school boy who has read Latin enough to translate Sallust and Cicero, ought to be, and probably is, able to render "de Magnete" into good English in about a fortnight.

Of course, in a matter concerning which the Lord Thomson and one plain Michael Faraday seem to be entirely divergent in opinion, the universe holds no one who is better able to arbitrate and set the whole affair to rights than Mr. Thomas D. Lockwood. It will always, therefore, be a source of regret to me that I should, however innocently, have incurred his displeasure by perpetrating what he calls "the unnecessary slur of the Gilbert article upon the acknowledgment by the Crown of Sir William's great merit and ability;" but, oh, shades of Jeames and Jenkins! when did you ever descend to such arrant snobbery and flunkeyism as even to imply that a great reputation in science could be made greater by "acknowledgment by the Crown"?

Of course Mr. Lockwood is far too good an American seriously to intend any such implication as this. He merely thinks, no doubt, that Lord St. Albans is a better name to conjure with than Francis Bacon; or perhaps mildly deplores that among all the statues of Benjamin Franklin which we have erected not one of them represents that philosopher in the official garb of a Royal Postmaster of New Jersey.

PARK BENJAMIN.

NEW YORK CITY.

EARLY IDEAS ABOUT RAILROADS, SPEED, ETC.

THE statement of Mr. Pope in your issue of January 20th suggests the addition of some others as to the ideas entertained by able men, in regard to railroads, in the infancy of the art.

In 1825, the *Quarterly Review*, in England, said, "We trust parliament will, in all railways it may sanction, limit the speed to eight or nine miles an hour, which is as good as can be ventured on with safety."

When it was first proposed to build railroads in the U. S., Chancellor Livingston, of New York, published a statement demonstrating, as he thought, the impracticability of the project. His reasons were, first, that the foundation would have to be of masonry, and would therefore be so costly as to render the scheme impracticable. Second, that the momentum of such a moving body as a train of cars would be such that the train could not be stopped until it had gone several miles past the place; and to clinch his argument, he wound up with the exclamation, "and who would want to risk their lives flying through the air at the rate of fifteen miles an hour!"

At the opening of the first section of the Baltimore & Ohio R. R. several prominent gentlemen were invited to take a trip, and among them was Mr. Seaton, editor of the old *National Intelligencer* of Washington, D. C.

He gave a lengthy account of the trip, the car being drawn by horses, on the old strap rail, and he states that they were kept in mortal terror lest some of the cows feeding by the wayside should get upon the track and derail their car. He discussed at length the future possibilities of the road and concluded that as a means of conveying freight it might be successful, as a horse could draw considerable more on the smooth rails than it could on a common road.

As to speed, he thought they might possibly go "twelve miles an hour, which is as fast as any one will ever want to travel."

The records of the past are full of such ideas and statements. For instance, about 1777, Smeaton was of the opinion the rotary motion of the axis of a steam engine direct "would never be useful economical," and he used his engine to pump water up into a cistern, and then used the water on a wheel to produce a rotary motion! Within the past ten years a party came to me with a proposition to do the same thing; and he was an educated man, too.

Watt had no faith in steam carriages or steamboats, and he refused to license parties to use his patent on the steam engine for such purposes. He also declared that Trevethick deserved hanging for introducing the high pressure engine!

All this sounds very strange to us now, but probably not much more so than our present ideas on many subjects will to our successors fifty or a hundred years hence.

W. C. DODGE.

WASHINGTON, D. C., January 22, 1892.

RINGING HOTEL BELLS WITH A MOTOR-DYNAMO.

IN reply to the very kind criticisms of Mr. Miner and Mr. Bartlett on my article in regard to ringing bells with a motor-dynamo, I wish to say that I have tried the plan suggested by Mr. Miner, viz., using a bell in series with a lamp resistance, and did not find it satisfactory; in fact, I find, as Mr. Bartlett did, that an arc would set up without ringing the bell, or that a destructive spark would soon pierce the platinum and finally oxidize the contact so as to entirely open the circuit. I overcome this by shunting the bell circuit with a resistance to correspond with the resistance of the bell circuit. This method, while very satisfactory under expert care, would not be a safe general plan for bell ringing, hence I did not mention it in my article of December 23.

I fear from the remark Mr. Bartlett made, that I did not make myself clearly understood as to my method of winding. My windings are both on the same shaft. I use but one machine with a commutator on each end of the shaft, with two windings upon this shaft. The windings are insulated from each other by a thick disc of fibre. This armature when withdrawn from the pole pieces appears like one long armature, with drum winding and a commutator on each end. The whole machine weighs but about 75 lbs. and yet will safely handle 500 bells, if necessary.

I have had these machines in use long enough to know that they are a practical success and hasten to assure Mr. Bartlett or any one else who has need for a constant supply of current for bell ringing in a considerable quantity, that they will make no mistake by adopting my method.

CHAS. S. ARMSTRONG.

CHICAGO, Feb. 6, 1892.

SOME NEW METHODS OF STORING ELECTRICITY.

HAVING for several years paid much attention to the study of the electric current, I have arrived at the following results:

1. Electricity can be produced in the most economical way directly from heat. (Coalfire.)
2. Electricity can be stored in steel by means of heat.
3. Electricity can be stored in steel by means of electricity.

To No. 1 I would add: Currents of any quantity and potential can be produced. These only limited by the capacity of wire and amount of heat used.

To No. 2: Any amount of electricity of variable potential can be stored, kept, used and transmitted independent of producer. Electricity so stored produces a tension of magnetic nature. The same can be used as motive power or recharged independent of the producer in electric current.

To No. 3: This way of storing is not economical, but will be of value where motive power (water power) is abundant and cannot be consumed directly.

These assertions are based on principles which explain the nature of the electric current and whose correctness I assert on the ground that the principal phenomena in electricity can be explained. I am willing any time to explain these principles when a compensation is guaranteed for my labors, providing their practical value is beyond any doubt.

PROSPER NABICH.

MOTOR-DYNAMOS FOR ANNUNCIATOR AND BELL CIRCUITS.

In reply to Mr. Bartlett, on the bell work question, in your issue of Feb. 3, I would say that I did *not* overlook the voltage on open circuit, but, perhaps did not express myself plainly enough in my former communication, in which I proposed using two or more lamps in series, the bell circuits being in shunt with one of the lamps.

As to the vibrating bell not working, as I suggested, on account of arcing at the contact points, I have been informed by thoroughly reliable parties that they have had bells working in that manner for a year or more, giving perfect satisfaction.

The motor-dynamo suggested by Mr. Bartlett is the same as that used to automatically balance the Thomson-Houston three-wire system of distribution, and I doubt if it would be any improvement, for bell work, over that of Mr. Armstrong's.

W. M. MINER.

PLAINFIELD, N. J.

DRY BATTERY LITIGATION.

IN an article in issue of February 10, on page 147 of THE ELECTRICAL ENGINEER, your attention is called to the last two lines under the heading of "Dry Battery Patents."

This company is not the manufacturer of any Dry Battery. We have been handling a number of different makes of dry batteries, and the battery in suit which the Burnley people claim this company has been unlawfully selling, is not the "Mesco" but the "Johnson" dry battery.

Yours respectfully,
Manhattan Electrical Supply Company,
J. J. GORMAN, President.

NEW YORK, Feb. 13, 1892.

Literature.

The Electric Railway in Theory and Practice. By Oscar T. Crosby and Louis Bell, Ph. D. *The W. J. Johnston Co., Ltd.* New York, 1892. Cloth; 400 pp. 6 x 9 inches. Price $2.50. *First Notice.*

ELECTRIC traction has so largely absorbed the time and energy of electrical engineers during the past five years that to undertake the complete record of the work accomplished would be a task of no small magnitude. The treatises which have thus far appeared have in the main been devoted to the very interesting history of this subject and to a mere detailed description of the apparatus employed, a part of the subject which will be admitted to be of no little importance, but which is hardly adequate to satisfy fully the minds of those who may be looking for the solution of those practical problems which present themselves in every-day electric railway work. It is largely with the idea of bringing together information on this latter subject that the authors have projected the work before us. In other words, they have made the present practice of electric railroading the subject of their labors.

The reader is introduced to the subject by a chapter on general electrical theory illustrating the principles of dynamo machinery and the nature of the magnetic circuit, following which is a chapter on prime movers, in which the general principles of water wheels and steam engines are briefly explained. The various types of motors and car equipment are then taken up and the nature of the street car motor is fully explained with special reference to the class of work which it is designed to do. In this connection the authors discuss the various advantages and disadvantages of motors operated with rheostats, commutated fields, etc. They also discuss the motor in its relation to the other necessary parts of the car, such as the connection of the armature with the axle, in which regard the various types of gearing are pretty thoroughly discussed. We also find an interesting section on trolleys, methods of car wiring and miscellaneous equipment, such as lightning arresters and general instructions for the care of motors.

That most important part of an electric railway system, the line or conductors, is then taken up and the authors show plainly the necessity of devoting as much attention to this part of the equipment as to any other, in order to attain success. The track, car houses and snow machines also receive their proper share of attention, and the arrangement of the station has very properly been made the subject of a chapter. For those who are of a critical turn of mind, the chapter on the efficiency of electric traction will afford much interesting information, entering as it does into the discussion of the various losses which are met with between the generating dynamo and the motor on the car.

In a work like this, naturally, storage battery traction must find a place, although it can hardly be said that the space devoted to this branch of the subject is adequate to its importance, the authors being evidently of the opinion that the time has not yet arrived for its serious consideration, owing to the present condition of the storage battery art. Underground electric traction is also touched on, though in a very small way, the authors being limited, no doubt, by the small amount of practical work which has yet been accomplished in this direction. We also find a short description of the telpherage system.

High speed electric railway service, the study of which Mr. Crosby has made peculiarly his own, is very properly given a chapter, in which we find a description of the City & South London Railway, and a very good discussion of the subject, based on the paper read by Mr. Crosby before the American Institute of Electrical Engineers.

"Commercial Considerations" is the title of Chapter XI, which constitutes one of the most important chapters of the work. In it the authors lay before us quite a complete résumé of the original investment, cost of maintenance and operation and gross income of electric railways, based on figures which are probably as nearly correct as they can be obtained at this time. Paradoxical as it may seem, the authors have reserved the last chapter in the book for a historical review of the electric railway, which we think might have been more in place at the beginning. The value of the work is also increased by a number of appendices, among them the decisions of the Supreme Court of the State of Ohio on the Electric Railway *vs.* The Telephone; very complete "Instructions to Linemen;" and "Engineers' Log Book," showing the method of keeping the records and classification of the expenditures of electric railways; and finally an appendix, "Concerning Lightning Protection," due to Prof. Elihu Thomson, in which he discusses lightning in relation to railway circuits and apparatus, with special reference to methods of protection.

We have here confined ourselves to but a brief outline of the contents of this work, which we have no hesitation in saying is the most valuable, on the lines which the authors have taken up which has thus far appeared. We can go further and say that every electric railway engineer and street railway manager will find in it many suggestions which may lead to increased economy in the operation of a road, while to the student the practical discussion of the principles involved will be of the utmost interest. We are sorry to note, however, that so good a work as this should have been put in so poor a dress.

DR. F. A. C. PERRINE has a very interesting article in the January *Engineering Magazine* on "The Altruistic Effects of Electric Power" dealing with some very important social and ethical questions raised by this new agent in the economical distribution of energy.

THE AUTOMATIC FIRE ALARM AND EXTINGUISHER CO., LTD., of 413 Broadway, has declared a dividend of 2 per cent.

Patent Notes.

THE PATENT OFFICE REPORT.

COMMISSIONER Simonds of the Patent Office has recently submitted his annual report to Congress. The report recommends the following amendments to the Patent and Trade-Mark law :

First—That no improvement shall be patentable which has been, for more than two years before application for patent thereon, disclosed in any patent or printed publication issued in this country.

Second—That a patent shall not expire with the expiration of a prior foreign patent for the same invention.

Third—Compelling an applicant to take action upon his application at least once in every six months, in lieu of once in two years, as at present ; and that a patent shall in no case live for more than twenty years from the date of the first application.

Fourth—Requiring patent licenses to be recorded the same as assignments and grants.

Fifth—Putting aliens upon the same footing as citizens as to the filing of caveats.

Sixth—Abolishing interference contests in the Patent Office and relegating them to the courts.

Seventh—Requiring a fee of $10 for every appeal or petition taken from a primiary examiner directly to the Commissioner of Patents.

Eighth—Providing that no damages or profits shall be recovered in a suit for infringement except such as accrue within the six years last preceding the bringing of the suit.

Ninth—Providing that an injunction issued by a court against the transfer of a patent may be registered in the Patent Office and thereupon be constructive notice to all the world.

Tenth—Giving courts of equitable jurisdiction power to pass on the title to letters patent in a proper case without any action on the part of the defendant.

Eleventh—That the Commissioner of Patents may refund to the payer money paid into the Patent Office by mistake.

Twelfth—Defining the duties of the Assistant Commissioner of Patents.

Thirteenth—Permitting registry of trade-marks which are used in commerce between the States, the permission now being restricted to trade-marks used in foreign commerce or in commerce with the Indian tribes.

The following is a summary of the business of the office during the last calendar year : Total number of applications received, excluding applications for the registration of trade-marks and labels, 40,552 ; total number of patents granted, 23,244 ; total number of registrations, 1,899 ; total receipts, $1,271,283 ; total expenditures, $1,139,713 ; leaving a surplus of $131,572 ; making a total balance in the Treasury to the credit of the patent fund of $4,004,317.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEBRUARY 2, 1892.

Alarms and Signals :—

Electric Signal for Mine-Shafts, F. W. Bacorn, 467,985. Filed July 28, 1891.
An annunciator signal for mine elevators.

Electric Signal System, H. F. Eaton, 468,107. Filed Mar. 16, 1891.
A police signal employing a metallic circuit for one class of calls and a ground circuit for the other call for the purpose of distinguishing them, and also that the occurrence of an accidental ground will not derange the system.

Electrical Annunciator, W. Ebert, 468,170. Filed May 20, 1891.
An annunciator for signaling back and forth between two distant places.

Conductors, Conduits and Insulators :—

Trolley-Wire Hanger, C. T. Lee, 467,940. Filed Mar. 20, 1891.
A double insulated hanger for use in connection with a yard arm.

Insulator, C. T. Lee, 467,941. Filed Sept. 28, 1891.
A line wire insulator consisting of two links imbedded in an insulating material.

Insulator, C. T. Lee, 467,942. Filed Nov. 11, 1891.
A mica insulator for trolley wires.

Insulating-Swivel, A. H. Englund, 468,053. Filed Oct. 12, 1891.
An insulating swivel for trolley line wires, etc., adapted to resist very severe longitudinal strain.

Electric-Wire Coupling, W. B. Lillard, 468,086. Filed Apr. 20, 1891.
Relates to means for readily connecting electric wires between railway cars.

Conduit Electric Trolley, M. Wheless, 468,166. Filed Dec. 1, 1891.
A trolley having three pairs of wheels one pair for each line of wire ; the two pairs which are for the lines of wire in the same circuit being insulated from each other.

Connector for Electric Wires, C J. Coleman, 468,293. Filed June 15, 1891.
An open sided sleeve having on its inner periphery a series of circularly arranged inwardly projecting teeth.

Conduit for Electric or Cable Roads, C. H. Bates, 468,314. Filed Jan. 26, 1891.
Relates to means for automatically opening and closing conduit slot as the car passes along.

Distribution :—

System of Electrical Distribution, H. W. Leonard, 468,099. Filed May 12, 1891.
A system of distribution adapted to localities where the demand for current spreads over a large area, not however being sufficient in the outlying districts to warrant the construction of a central station in the neighborhood, and where there is a large variation in the required current at different hours in the day.

System of Electrical Distribution, E. Thomson, 468.122. Filed Mar. 11, 1891.
Provides an effective means of maintaining a fairly equal potential on the different branches of a system in spite of inequalities of load.

System of Electrical Distribution, E. Thomson, E. W. Rice, Jr., 468,123. Filed Mar. 19, 1891.
Claim 1 follows :
The combination, with a multiple-series distributing system, of an equalizer connected to the intermediate conductor and reconverting the excess of energy into an electromotive-force-feeding current to the outer mains.

Dynamos and Motors:—

Electric Motor, J. W. Darley, Jr., 467,924. Filed May 24, 1890.
A motor in which the current passing through the armature remains constant.

Electric Railway Motor, H. M. Byllesby, 467,969. Filed June 16, 1891.
A railway motor in which the fields and armature are concentric with one another and independently rotatable about their axis, the armature being connected to one axle and the fields to the other so that the opposite rotations of armature and fields shall impart rotation in the same direction to both car axles.

Dynamo-Electric Machine, E. Thomson, 468,121. Filed Oct. 16, 1890.
Relates to means of building up the stationary magnet frame and also certain parts of the revolving consequent pole, in sections, thus facilitating construction and avoiding heating from Foucault currents.

Electric Motor Regulation, F. O. Blackwell, 468,128. Filed June 5, 1889.
Claim 8 follows :
The combination, with an electric motor, of a speed controlling device therefor, a reversing device and a common actuating handle for the two provided with connection to each corresponding to different movements of the handle.

Regulator for Electric Current Generators, G. Pfannkuche, 468,260. Filed June 22, 1889.
Has for its object to insure a prompt, sensitive and accurate regulation of the generator.

Lamps and Appurtenances :—

Incandescent Lamp Socket, W. L. Silvey, 467,958. Filed May 17, 1889.
A strong and simple double brake switch for lamp sockets.

Incandescent Electric Lamp, D. H. Piffard, 467.982. Filed May 26, 1891.
Employs a sheathing of solid non conducting moisture-proof cement covering the connections of the leading-in wires and line wires.

Incandescent Lamp Socket, D. H. Piffard, 467,983. Filed June 25, 1891.
A socket consisting of a tube of soft rubber adapted to fit snugly the socket of an incandescent lamp thereby preventing corrosion from acid fumes, etc.

Device for Raising and Lowering Suspended Electric Lights, S. M. Terry, 468.159, Filed May 4, 1891.
Consists of a spring barrel with a flexible connection wound thereon and incased in the ceiling rosette from which the lamp hangs.

Measurement :—

Electrical Measuring Instrument and Current Direction Indicator, J. J. Wood, 468,020. Filed Nov. 3, 1891.
An indicator showing at a glance the direction in which a current is flowing over a circuit.

Metallurgical :—

Process of Separating Aluminum, C. S. Bradley, 468,148. Filed Feb. 23, 1883.
Claim 4 follows:
The process of separating or dissociating aluminum from its ores or compounds consisting in fusing and maintaining the fusion and electrolytically decomposing the ore or compound by the passage of the electric current therethrough.

Miscellaneous :—

Electric Elevator, H. W. Leonard, 468,1000. Filed Aug. 31, 1891.
Claim 5 follows:
A method of reversing the motion of an electric motor consisting in reversing the field magnet of the generator supplying the armature of said motor.

Electric Fare Register, W. H. Gilman, 468,172. Filed Dec. 1, 1890.

Illuminating Sign, L. J. Webster, 468,185. Filed Aug. 5, 1891.

Electric Light Tower, C. A. Beardslev, 468,186. Filed Sept. 18, 1890.

Electric Elevator, A. Neuburger, 468.258. Filed July 31, 1891.
Relates to means for conveniently regulating the travel of electric elevators.

Magnetic Toy, G. A. Goodson, 468,274. Filed Mar. 21, 1891.

Railways and Appliances :—

Electric Railway, M. Wheless, 468,163. Filed Dec. 1, 1891.
Improved system of electric railway for underground work.

Electric Railway, M. Wheless, 468,164. Filed Dec. 1, 1891.
Similar to No. 468,163.

Electric Railway, M. Wheless, 468,165. Filed Dec. 1, 1891.
Similar to No. 468,163.

Switches and Out-Outs :—

Electric Cut-Out, A L. Clough, 467,919. Filed Aug. 24, 1891.
A device for opening electric circuits at some determinate time after their closing.

Cut-Out, J. B. Murphy, dec'd, M. J. Murphy, administratrix, 468,101. Filed June 14, 1890.
Relates to mechanism for automatically breaking the current the intensity of which has become too great.

Electric Switch, E. Thomson, 468,119. Filed July 14, 1890.
The combination of switch contacts with a series of three or more conductors of different resistances operated serially in the order of their respective conductivities.

Method of and Means for Interrupting Electric Currents, E. Thomson, 468,120. Filed Sept. 1, 1890.
A method of avoiding arcing on the interruption of electric currents of high potential for lightning-arresters circuit-breaking switches, etc.

Electric Switch, A. Wright, 468,125. Filed July 13, 1891.
A spring-actuated quick-break switch.

Telephones and Apparatus:—

Telephone-Holder, J. A. Christy, 467,917. Filed July 12, 1890.

Telephone Receiver, E A. Grissinger, 468,246. Filed May 29, 1891.
Receiver for intensifying the sound waves.

Cut-Off for Telephones, E Cann, 468,281. Filed Oct. 3, 1890.
Relates to means of reducing the number of conducting wires by enabling the number of telephones to be attached to one circuit.

MR. EMIL KOLBEN, for the past four years the electrician of the Edison Works at Schenectady, was tendered a farewell banquet on Wednesday evening, February 3, by about fifty gentlemen prominent at the Edison factory. An excellent musical programme was given, and speeches were delivered which showed that Mr. Kolben has made many warm friends in the Edison company.

A presentation was made of a handsome Weston voltmeter and a silver bronze plaque with the head of Thomas A. Edison in relief. Mr. Kolben will take back with him to Europe the regards of many friends who wish him success in his work on the Continent. It is rumored that he will be associated with the Oerlikon Works in Switzerland.

TRADE NOTES AND NOVELTIES

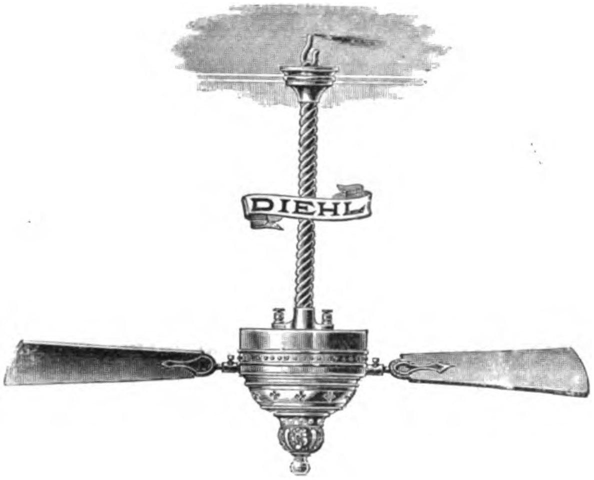
AND MECHANICAL DEPARTMENT.

If you advertise well, you will have something to "consolidate."

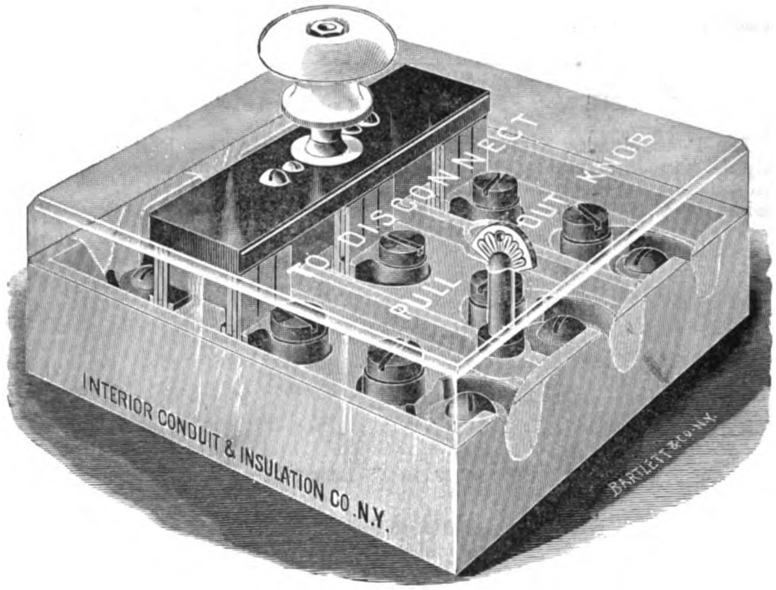
THE DIEHL ELECTRIC FANS.

The Diehl suspended motor fan, as shown below is one of the many designs in electric ventilating devices which Diehl & Company, No. 385 Broadway, this city, will place upon the market the coming season. The motor from which the power is obtained is contained within the basket. To the wheel which encases the revolving armature are attached the blades. The spindle revolves on a roller bearing within a tight oil cup which affords lubrication. The wires pass up through the tubing connecting with the line wires at the top. All liability of the motor heating has been overcome, its electric efficiency is unquestioned and its mechanical construction is of a correspondingly high class. It can be operated on a direct incandescent or arc current with equal success.

No more ornamental or attractive appliance could be desired than the suspended fan finished in handsome nickel or polished brass. No unsightly shafting or belting is required and there is no more disfigurement to the ceiling than in the hanging of a chandelier.



Diehl Electric Fan.


TO DISCONNECT PULL OUT KNOB
INTERIOR CONDUIT & INSULATION CO. N.Y.

The "V. V." Combined Plug Switch and Main Line Cut-Out.

By the simple turning of a switch they are set in motion; and where desired a novel attachment can be supplied to each fan not only for starting and stopping but for regulating the speed.

The firm also have an attractive assortment of floor, counter, column, bracket and their improved propeller fans.

The popularity with which those goods were received last season compelled the company to greatly increase their manufacturing facilities and they are now prepared to meet all demands in a thoroughly prompt and efficient manner.

THE "V. V." COMBINED PLUG SWITCH AND MAIN LINE CUT-OUT.

Electrical switches for breaking currents of both large and small capacities may be divided into two classes. 1st, those that are required for constant use. 2nd, those that are but seldom called upon to perform the service for which they are designed. The key socket is a ready illustration of the former, and the huge feeder switch of the latter class. To the first class many new designs are contributed from time to time, but in the latter, the use being to a certain degree limited, but few are well known enough to deserve recognition. The device illustrated herewith, is a switch of the second class, and is known as the "V. V." Service Cut-Out, the invention of Mr. J. H. Van Vleck, the electrician and chief engineer of the Edison Elect. Illg. Co., of New York, for whose special requirements the switch was originally designed.

The Fire Underwriters in the principal cities require the placing of a switch and cut-out in the main line of every circuit entering a building, which can be readily disconnected, in case of necessity by the firemen, and when so disconnected insures that the current is absolutely shut off.

The above switch combining in a compact form within itself a switch and cut-out, has filled this requirement to the entire satisfaction of the N. Y. Edison and other well known illuminating companies.

In this device, the extra cost of the switch arrangement is but a small additional expense over the necessary safety cut-out, so that the combination fills a gap between the conditions where the expense of a regular snap switch and cut-out would be unwarranted, and where a cut-out without a switch would be incomplete.

The switch is constructed wholly of fire-proof material; its base and cover being of the best quality of porcelain. It is made for the two and three-wire systems on the plan illustrated, from which it will be seen, that one-half of the device embodies the ordinary safety cut-out principle for holding the safety fuses, while in the other half there is a novel form of quick acting snap switch.

The connections are of bronze of ample capacity, with strong screws for the binding posts; the contacts made by means of the plug are admirably fitted, and when the plug is withdrawn to open the circuit, the movement is accelerated by means of a strong spring which is contained in the plug itself, insuring a rapid and complete break with a sharp snap action. The only exposed portion of the plug is finished hard rubber, the whole presenting a neat and attractive appearance.

The use of this appliance is however by no means limited to the above particular purpose, but is offered by the Interior Conduit & Insulation Company, of New York, for general use.

SIOUX CITY ENGINE WORKS, SIOUX CITY, IA.

It is now practically assured that the business of the Sioux City Engine Works will be reorganized, and that there will be placed at the disposal of the Company what has long been needed—ample capital to conduct the business upon business methods. It is long since the business outgrew its capital. In spite of all obstacles, however, the sales have been doubled in 1891, and at the beginning of the present year, the Company had a large number of contracts upon its books, a large and valuable stock of material on hand, and excellent business prospects for the future, the only thing lacking being sufficient working capital.

STRATTON SEPARATORS FOR U. S. GOVERNMENT CRUISERS.

The Stratton Separator Company, 32 Cortlandt Street, New York City, have recently furnished to the Columbian Iron Works & Dry Dock Co. of Baltimore, Md., several large separators for use in the new cruisers Nos. 9 and 10 which they are now constructing for the government. These separators are of the naval type especially constructed with steel shells and brass heads to meet the requirements of the United States Navy.

THE SHORT GEARLESS MOTOR.

A series of interesting tests has just been made in Cleveland in order to determine the relative merits of the various new types of street car motors recently put out by the different companies. A prominent engineer of the West was sent by his clients to report particularly upon the Short Gearless motor and the single reduction motors of other makes. The tests were made by attaching two motor cars together and running the train with each alternately over a measured stretch of track. The power consumed was measured by the Thomson-Houston wattmeter. Dynamometers were placed between the cars, the readings taken showing the power required to pull each car as a trailer. The utmost care was taken to secure reliable results. It is interesting to note that the doubt in the minds of many street railway people concerning the power consumption of a gearless motor, was proven to be without foundation. The gearless motor was nearly at the bottom of the list, showing an extremely high efficiency, greater even than several of the double reduction motors, which were also tested as a basis for general comparisons.

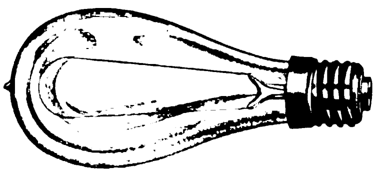
It was found that the gearless motor car was slower in speed than any of the single reduction motor cars, showing that Mr. Short's efforts to make a slow-speed motor have been entirely successful; in fact it has been found necessary to wind the motor for a higher speed in order to meet existing conditions of street railway work.

Another feature of the Gearless motor car was the fact that the power required in drawing it as a trail car was less, as shown by dynamometer readings, than that required for the single reduction motors.

The Short single reduction motor showed a very high efficiency in all the tests made.

THE NEW "PENNSYLVANIA" LAMP.

The Pennsylvania Electric Engineering Company, of Philadelphia, have lately put upon the market a new lamp, which they claim has all the merits of the best lamps of other manufacturers, besides overcoming the difficulty presented by the vapor of mercury. Their lamps are exhausted with mechanical pumps, which are claimed not only to produce a higher vacuum, but secure far more uniform results than are possible by the old method. The above-named company claim that with their process of mechanical pumping they can produce a lamp which shall have an average life of 1,000 hours, and can be successfully operated, maintaining 14.2 sixteen candle-power lamps per horse-power.



THE "PENNSYLVANIA" LAMP.

The following is an impartial test made by an electrical expert:

Candle-power, (English Standard).	E. M. F. in volts.	Current in Amperes	Efficiency Consumed in Watts.	Efficiency per Watts, Candle-power.	Lamps per Horse-power.
16	50	1.02	51	3.19	14.2
16	75	.70	52.5	3.28	14.0
16	100	.54	54	3.37	13.8
16	110	.50	55	3.44	13.5
25	50	1.55	77.5	3.10	9.6
25	100	.80	80.8	3.20	9.8
32	50	2.02	101	3.16	7.4
32	100	1.00	100	3.12	7.5
50	50	3.30	165	3.3	4.5
50	100	1.70	170	3.4	4.4
75	50	4.90	245	3.26	3.0
75	100	2.60	260	3.46	2.9
100	50	6.85	342.5	3.42	2.2
100	100	3.60	360	3.60	2.1
125	150	2.80	420	3.36	1.7
150	50	10.00	500	3.33	1.4
150	100	5.40	540	3.60	1.4

Other notable features of this lamp are the unusual brilliancy of the light, graceful uniformity of the bulbs, and the length of the filaments, as shown in the accompanying illustration. Altogether, it is a lamp of the highest grade of manufacture.

THE PELTON WATER WHEEL CO.

THE above company have recently furnished the Commercial Mining Co. of Arizona a power plant which affords a good illustration of the results that can be obtained from a small quantity of water under a high head, as also the estimate of value placed upon a water power even under such extreme conditions. This plant consists of a 4-foot Pelton wheel which runs under a 1,200-foot head at 690 revs. per min. developing 45 h. p. using a nozzle tip $\frac{58}{100}$ of an inch in diameter. Also a 24-inch Pelton wheel running under the same head at 1,380 revs. developing 20 h. p. with a nozzle tip $\frac{35}{100}$ of an inch diameter.

These wheels are to run a concentrating and smelting plant including rock breaker, blowers, pump etc. The pipe line is 20,000 feet in length the upper end being 5 and 6 inch casing, the lower end 5-inch lapweld pipe. All the water supply that can be counted on during the dry season is a flow of about 30 cubic feet per min. The large expenditure here made in pipe line for a comparatively small amount of water, will indicate the advantage that water power has over steam even under what may be considered, unfavorable conditions.

HUNT ENGINEERING CO.

WE take pleasure in noting the fact that arrangements have been made for the reorganization of the Hunt Engineering Company, which will take effect on February 1st. Mr. J. M. Brown, of Brooklyn, well known in business circles as an energetic financier and capitalist, has purchased the balance of the treasury stock of the company, has been elected treasurer, and will have control and management of the finances, Mr. George W. Hunt retaining the presidency and Mr. Albert F. Rich continuing Secretary and General Manager. Mr. H. C. Willis, formerly of the firm of T. F. Hunter & Co., 33 Church St., well known to all connected in the electrical supply business as an energetic and pushing salesman, will have charge of the supply department. New quarters have been leased for the manufacturing of their many electrical devices, which are meeting with a ready sale, and they look forward to a successful year's business.

POND ENGINEERING CO.

THE Electric Light Company, Albuquerque, N. M., have telegraphed an order to the Pond Engineering Co., St. Louis, for a 100 h. p. Armington & Sims engine. This is their third order within one year. The Equitable Gas Light & Fuel Co., of Chicago, have also contracted with the Chicago office of the Pond Engineering Co. for an Armington & Sims engine, to drive a large exhaust fan. This plan is already in use by two other gas companies in Chicago, and is proving very popular in gas plants.

RAW-HIDE PINIONS ON ELECTRIC RAILWAYS.

THE Auburn City Railway Co. have addressed the following letter to President T. W. Meachem, of the New Process Rawhide Co., of Syracuse, N. Y.:

We wish to state to you our approval of your patent raw-hide pinions furnished by you and now running on our motors here.

We have had a nine months' experience with them and find they fill all requirements.

Motors equipped with them run a great deal more quiet, and they will with ordinary care outlast the metal gears used.

They require to be kept free from oils and the ordinary car equipments can be kept much cleaner in that respect.

You are at liberty to use our recommendation and may refer any parties to us whom you may see fit.

Very truly yours,
(Signed) AUBURN CITY RAILWAY CO.
A. H. UNDERWOOD, Secretary

LA ROCHE ELECTRIC WORKS.

AN excellent catalogue of apparatus for electric light and power has just been issued by the La Roche Electric Works, of 116 and 118 North Sixth street, Philadelphia. The apparatus is built under the patents of F. A. La Roche, and includes a variety of machines and lamps for both direct and alternating work, as well as meters, indicators, etc., and the other appliances that go to a complete plant. The pamphlet includes also pictures of some of Mr. La Roche's installations recently shown in these pages. Another section embraces a number of testimonials as to the thorough and satisfactory work of the concern, which has built up a rapidly progressive business on solid merit.

FARADIC, PAR EXCELLENCE.

FROM among many flattering testimonials lately received by the Jerome Kidder Manufacturing Co. the following letter is selected. To attempt higher praise would be to paint the lily:

JEROME KIDDER MANUFACTURING CO.,
820 BROADWAY, NEW YORK.

The No. 1 Electro-Medical Apparatus arrived all O. K., and it is certainly one of the most faradic batteries we have seen and we are highly pleased with it.

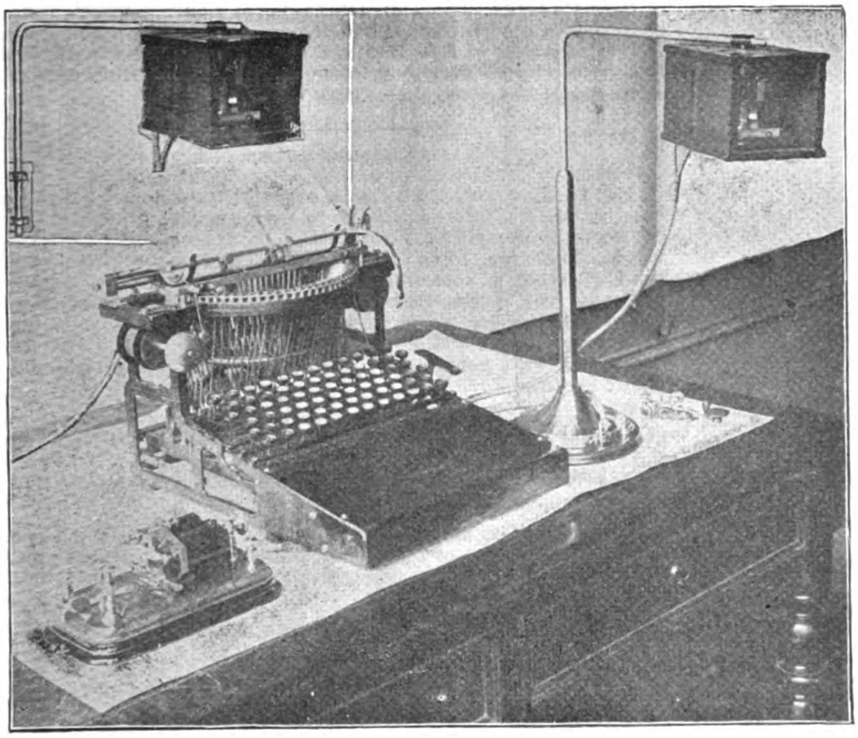
Very respectfully,
TEX. MED. PUB. CO.,
Per W. B. BROOKS,
Manager.

THE BUNNELL ADJUSTABLE SOUNDER SUPPORT AND RESONATOR.

THE typewriter, in place of pen and pencil has been extensively adopted during the past two or three years in numerous telegraph offices, but its use has been attended with some difficulty owing to a tendency to confuse the receiver, caused by the click of the machine being sometimes as loud as that of the sounder. This interference being now entirely eliminated will doubtless bring typewriter receiving into still more general use.

To avoid this difficulty, Messrs. J. H. Bunnell & Co., of this city, have just brought out the novel device illustrated in the accompanying engraving, designed to increase the sound of the instrument and to adjust its position so as to bring it as near as desired to the operator.

The sounder, which is of the well-known Bunnell "Giant Sounder" pattern is clamped within a very resonant box which is open at both ends and is sustained in mid air by a swivel pendant on a swinging arm. This arm is also adjustable to be raised to, or lowered from, any height within the necessary range, and as the arm also swings laterally on its support the operator can have the sounder wherever it is wanted. The effect of clamping the sounder within this peculiar resonating box, is to increase its loudness and distinctness to a startling extent, leaving nothing more to be desired in that direction unless the operator is nearly stone deaf, for the instrument, with its enormously increased sound, can be brought so close as to almost touch the ear if desired.



THE BUNNELL SOUNDER SUPPORT AND RESONATOR.

Under these circumstances, no typewriting machine, however noisily it may click or clatter, can interfere in the least with receiving by sound. In railway telegraphy, at noisy stations, in stock exchange telegraph offices and in every possible situation where the telegraph must be operated in the midst of the roar and din of such forms of modern daily business as are inseparable from noise, this device will be a welcome facility and will add to the accuracy of the work done. On the other hand it is frequently desirable that no eavesdroppers should become aware of what is coming over the wires, and to accomplish this, the device can be so adjusted that the instrument cannot be heard by any one except the operator who is taking the message.

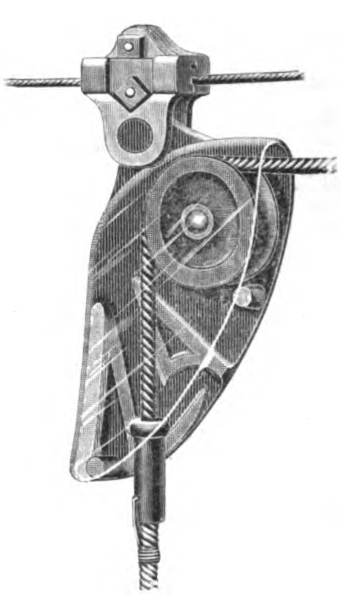
PARTRICK & CARTER CO. OF PHILADELPHIA, advertise their "New" box bell in this week's issue. This bell possesses many points of merit, and is likely to be well liked by the trade. They are made in three sizes only at present, of all the regular woods such as walnut, oak, cherry, plain and antique oak and cherry stain. The circular which the firm has issued gives special prices according to quantity ordered.

CUTTER'S LATEST PULLEY.

AMONG the devices which have seen marked improvement during the past few years, are the pulleys used for suspending arc lamps. The ordinary galvanized block was not adapted to be readily secured to a suspension wire and was by no means weatherproof. What is more, there was the need of some means for keeping the lamp from falling in case the hoisting rope should slip.

A simple and effective pulley which met all these requirements was the lamp-supporting pulley illustrated by us a year ago. This had the same arrangement of a knob and guides which is found in the most recent form, and its success is well vouched for by the attempts made by others to accomplish the same end. These have been quite numerous, and all have a system of cams or catches exposed to the weather. With them, it is necessary to stop the pull on the hoisting rope at a certain point, which is quite a problem when it is getting dark or when the trimmer's hands are benumbed with cold.

Cutter's lamp-supporting pulley evidently scores a point here, as it enables the trimmer to pull on the hoisting rope until the knob reaches a dead stop; then on slackening the rope the lamp is left hanging from the pulley. The new pattern shown in the cut has a swivel clamp which is readily secured to the suspension wire or cable, and which allows the pulley to tilt slightly when engaging or releasing the knob. All parts are strongly made and are well protected from sleet and ice. This new form is already in service in scores of places, and George Cutter is well pleased with the comments made by the users.



A NEW CUTTER PULLEY.

THE ELECTRIC MERCHANDISE CO.

THE founders of the Electric Merchandise Co., of Chicago, whose growing volume of business has surprised even themselves as the Spring opens up and the preparations of scores of new electric roads make themselves felt, are reaping some of the fruits of the wisdom of their early plans and methods. Their very choice of a name might be said to be indicative of coming success, it was so shrewd and novel; while their prompt selection of a new field for exploitation displayed the courage that has made not a few great institutions. In studying the devolpment of industrial and commercial enterprises it is interesting to observe sometimes the ingenuity and felicity with which an idea will be pushed to its full, so that when the mind is turned to any given branch of trade, a certain concern is sure to crop up in thought at once, as though it had secured a broad title of pre-emption to the territory, and had covered the domain with its name, very much as one of the old feudal leaders carved out a big principality with his sword, and then associated his impressive dignity with it for ever. This kind of thing is more difficult in commerce than in con-quest, just as brain is higher than brawn; and the newspaper man when he dubs the geniuses or workers or financiers who have "arrived", by some fancy title that once marked the old form of pre-eminence, he is not so very reprehensible after all. If there is anybody to-day who can think of street railways and electric railway supplies without at the same moment thinking of the Electric Merchandise Co., he will make a good exhibit for the curiosity department of the World's Fair. The mere existence of such an individual would be enough to make Mr. W. R. Mason feel that he had lived and advertised in vain. But in point of fact he doesn't feel that way at all. Some one has said that a good way to succeed is to "strike the note of distinction," and Mr. Mason sums up his philosophy on the subject in the corollary that the best way is to "keep on striking it."

NEW YORK NOTES.

The Fitch Battery & Electric Co., of Oneida, N. Y., have recently issued a very interesting catalogue descriptive of the "Perfect" battery of which they are the sole manufacturers. That this is not a misnomer may be inferred from the many gratifying letters received, a few of which they have published, attesting its merits. In the latter part of the book some pages have been left blank for memoranda.

Waite & Bartlett Manufacturing Co., of 143 East 23d street, recently furnished a large Holtz machine for Dr. Rockwell's lecture on the physiological effects of electricity before the electrical section of the Brooklyn Institute. It was of the latest and most approved form. They also exhibited a Wimshurst influence machine and some excellent Leyden jars.

Arrangements have just been perfected by the Security Insulator Co. whereby they are enabled to fill all orders promptly and at greatly reduced rates.

NEW ENGLAND NOTES.

H. N. Bates and Company, of Boston, have just issued one of the handsomest catalogues, if not the most handsome, ever presented, showing a general line of shafting, clutches, pulleys, and various kinds of machinery for the transmission of power. The book commences with a description of the famed Hunter friction clutch cut-off coupling, for which this company is the sole selling agent, and shows it as applied to varied kinds of work. The Hunter friction quill as illustrated in the Catalogue is particularly interesting to electrical engineers, as it enables them to lay out stations with countershafting, with the main pulleys supported entirely on a quill with independent bearings. The strain of the main belt is thus taken up on independent bearings, and the engine can be started up entirely independently of the shafting. The catalogue contains numerous cuts of Hunter friction clutch pulley, single and double armed, and a comprehensive price list from 18 inches diameter to 116 inches diameter. There is also a valuable set of tables of whole and split iron pulleys from 6 inches to 108 inches diameter, and split wood pulleys from 9 inches to 108 inches diameter. Besides these the catalogue contains numerous illustrations of various kinds of pulley and belt drives, belt tighteners, adjustable belt carriers, iron and steel shafting, couplings, gearing, hangers and all kinds of shafting brackets and pillow blocks. The floor stand with adjustable pedestal and loose pulley bracket attached, is worthy of special mention, as being used largely in connection with dynamos, and is used to relieve the dynamo from the strain of the belt when the belt is shifted on to a loose pulley. The book concludes with a valuable treatise on the dimensions of hangers, pillow blocks, floor stands, couplings, &c., and will be found to be an extremely useful and necessary addition to the library of every engineer who is engaged in designing plants for any kind of machinery. The book is handsomely bound, and is profusely illustrated, and reflects great credit on Messrs. Bates & Company, and a copy should be in the hands of every electrical and mechanical engineer.

The Berlin Iron Bridge Co., of East Berlin, Conn., are just completing a new machine shop for the Bridgeport Machine Tool Co., at Bridgeport, Conn. The building is made entirely of brick and iron, divided into two parts, each 40 feet wide, the total length being 96 feet. One portion is two stories high, the roof and floor being designed for light work, while the opposite half of the building is of the same height but the second floor is omitted so that it may be used as an erecting shop. The erecting shop is controlled by a traveling crane. The building when completed will be one of the most perfect and best designed machine shops in the New England States.

The Tripp Manufacturing Company of 180 Summer St., Boston, recently shipped 19 of their standard roller bearing trucks to the Central Electric Railway, of Sacramento, Cal. Mr. Lewis, the general manager of the road, spoke so highly of these trucks that the Oakland, San Leandro & Haywards Road, of Oakland, have ordered 12 similar ones on his recommendation.

Mr. J. Bradford Sargent, of Boston, agent in New England for the Cooper Corliss Engine Company, of Mount Vernon, O., has secured the contract for three 500 h. p. Cooper Corliss compound condensing engines, to be installed in the new station of the Lowell and Suburban Street Railway Company at Lowell, Mass. These engines have a very high reputation, and will be similar to the 450 horse power engine recently installed by Mr. Sargent in the plant of the Leicester and Spencer Street Railway Company, near Worcester, Mass.

Perry and Demeritt, of Montpelier, Vt., are meeting with marked success with the "L. P. and D." system of transmitting power to dynamos. This system can be applied either direct to the engine flywheel, or to the pulley on a countershaft, and saves all the space occupied by long belt drives. Perry and Demeritt have established agencies in the West, with parties who are well pleased with the system, and their business has grown so large, that they are now making arrangements to extend their manufacturing facilities.

Albert and J. M. Anderson, of Boston, have recently received orders from the West End Street Railway Company of Boston, for several thousand pieces of their well known Ætna insulating devices for electric railway work. They are also in receipt of some large orders from the Newark Passenger Railway Company, of Newark, N. J., the extension of the Paterson Street Railway Company, Paterson, N. J., and the Trenton Passenger Railway Company, of Trenton, N. J.

The Chester Pipe and Tube Co., of South Chester, Penn., have placed the contract for their new building with the Berlin Iron Bridge Co., of East Berlin, Conn. The building will be 52 ft. in width by 170 ft. in length and constructed of iron, no wood work being used about the construction.

ST. LOUIS NOTES.

Mr. W. L. Arnold, St. Louis, agent of the Thomson-Houston Electric Co., has lately made the following sales: The City Electric Street Railway Co., Little Rock, Ark, 20 arc lights; Iowa Iron Works, Dubuque, Iowa, for the U. S. Government torpedo boat No. 2, 20,000 c. p. search light and 100 incandescent; Missouri Malleable Iron Works, East St. Louis, 50 arcs and 450 incandescent. Construction of the plant in the Wainwright Building is now under way. The installation will consist of three 50,000 watt and one 15,000 watt generators driven by four Westinghouse compound engines.

Mr. G. Pantaleoni, Western representative of the Westinghouse Electric Co., reports the following sales: Leggett & Meyers Tobacco Co. 1,600 lights; Westlicher Post Association 700 lights; D. Crawford 250; Geo. Fowler Sons & Co., Kansas City, 1,600 lights; Salisbury, Mo., 750 lights.

The Short Gearless Motors are now in successful operation on a thirty-foot car of the Lindell Railway Co. The Short single reduction motors are also being given a trial on one of the Lindell Railway Co's. thirty-foot cars.

The Edison General Co. are fitting up spacious quarters on the ground floor at 728 Locust street.

WESTERN NOTES.

Mr. S. F. B. Morse, the inventor of Morse's lightning calculator for electric light circuits, which is meeting with a large sale among electrical people generally, has completed and copyrighted a similar calculator for motor circuits, motive power and street railway service and available efficiency of water-powers, which will be placed on the market in due time by Edward Lasell of Kansas City, Mo.

Vulca Ducts.—Among plants equipped with Vulca ducts by the New York Insulated Wire Co., through Mr. G. H. Meeker, their Western manager, may be mentioned the Wausau Court House, Wausau, Wis., Pabst Hotel, Milwaukee, and Maus Office Building, Indianapolis.

George Cutter says that he can sell the new interior conduit "Buildite" quicker than the factory can ship it, but still has hopes of having a stock at Chicago soon.

Mr. P. C. Ackerman, agent of the American Electrical Works, No. 10 Cortlandt street, New York, spent some time in Chicago last week.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

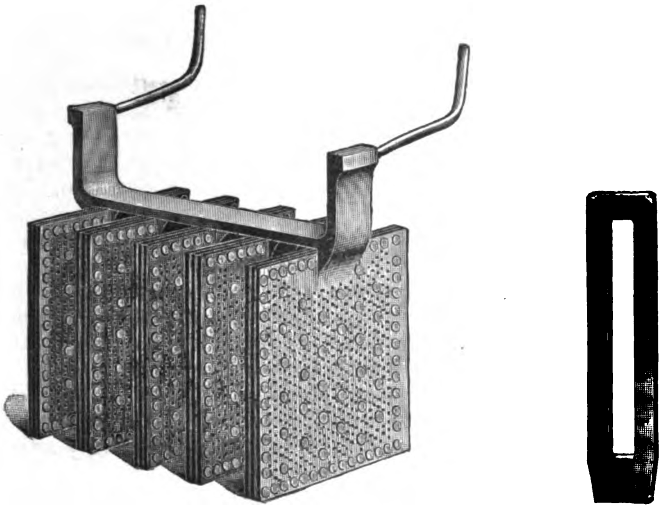
THE
Electrical Engineer.

Vol. XIII. FEBRUARY 24, 1892. No. 199.

THE "MAIN" HIGH VOLTAGE STORAGE BATTERY.

THE ordinary types of storage batteries in which the active elements are lead and oxide of lead, respectively, are known to give a working difference of potential of about 2 volts; their construction, also, has involved the employment of lead, one of the heaviest metals. In order to obviate both these drawbacks and to obtain a cell which should give an increased working E. M. F. with diminished weight, the use of zinc was early advocated, and M. Reynier, among others, has devoted considerable attention to the lead-zinc battery. Up to the present, however, this type of cell cannot be said to have met with much success, due principally to the great solubility of the zinc in sulphuric acid and also to the lack of a permanent backing upon which it could be redeposited.

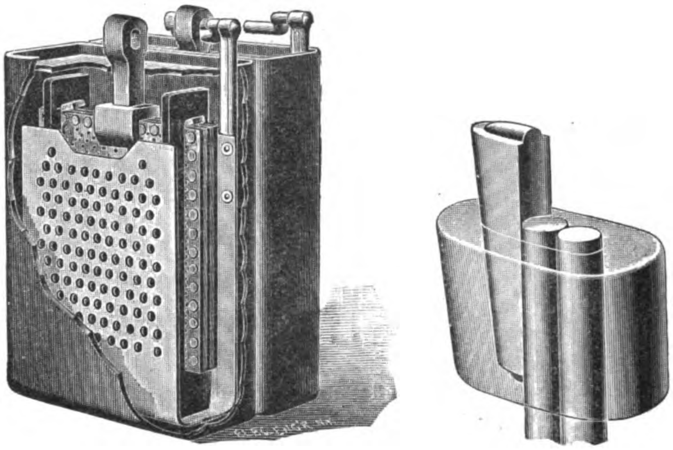
It was with these defects principally in mind that Prof. Wm. Main some time since began experimenting on this type of cell, and the results of his labors are now embodied in a storage battery just brought out by the Union Electric Co., of this city, who are manufacturing under the patents of the River & Rail Electric Light Co.



Figs. 1 and 2.—Positive Electrode of Main Cell, and Separator.

The manner in which Prof. Main has accomplished these results will be understood from the engraving, Fig. 1, which shows the positive electrode of a single Main cell of the type known as F 5. It consists of five lead plates connected by a cross-bar, also of lead, to which terminals are secured to connect with the negative electrode of the adjoining cell. Each of these plates is made of a number of thin sheets of lead, enclosed between two stout outer sheets. These are all perforated simultaneously in a press and secured together by numerous leaden rivets. Sometimes, as shown in the illustration, there is also a centre sheet of the thicker lead.

The plates built up in this manner are then "formed" by the prolonged action of a charging current, which converts the thinner inside sheets completely into peroxide of lead, leaving the thick ones, which are but superficially affected, as permanent retaining walls and supports. The transverse holes which remain open give free access of current and fluid to the interior of the plate. The working surface thus obtained is much greater than the outer flat sides would afford; no peroxide can drop out, and the plate, however thick, is discharged uniformly throughout.



Figs. 3 and 6.—Main F 1 Cell, and Connector.

Fig. 2 shows the hard rubber separator employed, two of which are slipped over each lead plate, serving both as supports, and preserving the space between electrodes, which is greater than in that usually allowed for in storage cells.

The cells of different sizes are designated F 1, F 2, F 3, etc., according to the number of plates in the positive electrode, but the plates themselves are all of the same size, viz., a little over six inches square. Each plate will yield 100 watt-hours under a moderate rate of discharge, so that an F 5 cell has a capacity of 500 watt-hours, the number indicating the number of hundreds of watt hours to be expected.

Fig. 3 shows the interior of one of the F 1 cells, and Fig. 4 the method of connection. The negative pole or electrode, in all of these cells, differs even more widely than the positive in its construction from the usual methods. It is made of an amalgam of zinc and mercury, deposited electrolytically upon a copper plate.

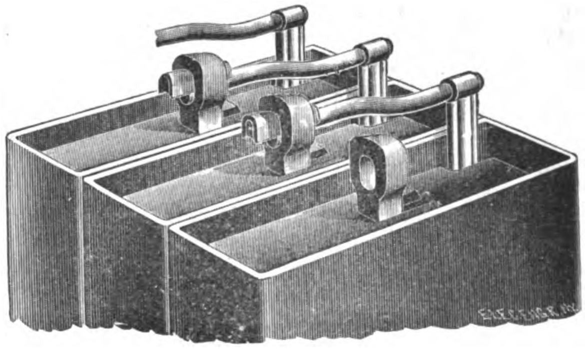


Fig. 4.

Zinc gives a higher electromotive force than the spongy lead usually employed, and but little of it is required. It is partly dissolved during the discharge of a cell and redeposited upon the copper plate by the charging current, so that there is no loss. The copper support gives permanence and high conductivity to what would be otherwise a perishable plate, while a small amount of mercury suffices to prevent local action, as it spreads by capillary action over the whole surface. The copper sheets are of No. 22 gauge, but the deposited zinc amalgam, with which they are coated, alters their form but very little, although, of course, making them somewhat thicker and rougher than they would be otherwise. Each copper sheet has a number of large perforations through it, giving a better hold to the soft amalgam, and it is long enough to bend into a U form, so as to come opposite to both sides of the lead plate. These sheet copper U's are riveted together in numbers corresponding to the lead plates. A complete F 5 cell is shown in Fig. 5.

The method of connecting the elements of the cells is one of the most simple and effective which we have yet noticed. The connecting wires are of copper, solidly coated with lead. The clamp which is shown in Fig. 6, is an oval collar of hard lead alloy, slightly tapered in one direction to correspond with a key wedge of the same material, which is lightly rapped into place, or pressed in with pliers. The inner face of the wedge is hollowed to fit the wire, so that a considerable surface is driven firmly into contact. Rapping the collar downward, with a light, quick stroke, or the application of pliers to the small end of the key and the upper face of the collar, loosens it in a moment.

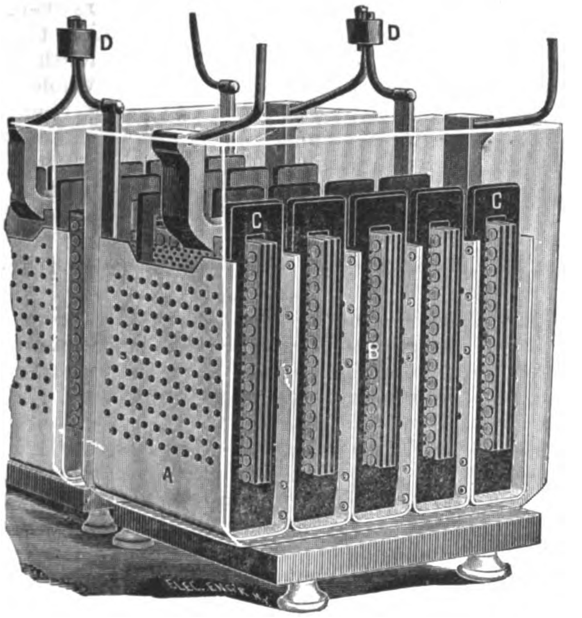


Fig. 5.—High Voltage, Main F 5 Cell.

This connection exposes no brass or copper to the action of acid, is made wholly of conductive and non-corrodible material, and has proved reliable under the most trying conditions. All cells except the types F 1 and F 2 have double connections, ensuring a high degree of conductivity. Single plate cells are connected as shown in Figs. 3 and 4, the lead-coated wire from the negative plate being passed into an eye in the solid lead terminal of the next positive and keyed fast.

All of the cells may be taken apart by simply lifting out the positive electrode.

From the fewness of the plates and their distance apart, it might appear to some that the internal resistance of these cells would be higher than desirable. This is not the case, for it will be found upon calculation, and has been proved by experiment, that the battery fluid can cause but a small part of the internal resistance of storage batteries, which is due mainly to the *character of the surface* of the plates employed.

In this case the peculiarities of construction all favor conductivity, for the surface of a negative plate remains the same throughout the discharge, and the positive shows no visible formation of sulphate of lead at any time. For this reason the positive plates may be thicker, fewer and more widely spaced; this affords a more solid and simple construction, while the internal resistance remains as low as in cells of corresponding capacity, but carrying a large number of closely set plates of the common "grid" pattern.

It will also be noted that, in contradistinction to the usual grid form of plate, in the plates of the Main battery the absorbent material, instead of filling an extended series of cavities opening outward is solidly enclosed between continuous sheets, so that it cannot work out.

These cells have an increased voltage of 20 per cent. over that of the "lead" batteries and possess the property of discharging at high rates without buckling or disintegration or injury of any kind whatever.

NOTES ON ELECTRIC STREET RAILWAY CONSTRUCTION.—II.

BY

A. K. McCay.

CAR CLEANING AND CAR INSPECTING.

The one branch of electric railroads which demands system, constant care and faithful work is the inspecting and cleaning of the motors. On the result of this being well done will depend the life of the motors, the size of the repair bill and even the success of the whole system. The motors should be inspected once a day by a competent, regular inspector, who should instruct the motor man at the same time what faults are likely to arise.

This point, the instruction of motor men, should be impressed on managers, a motor man should know every fault his motors are liable to, he should not only be able to start and stop the car like an automaton but should be able to remedy any small defect, at least to replace a brush or to know if his armature is flashing sufficiently to cut it out. This instruction will pay and I strongly advise it.

This inspection should take place preferably at the end of a route, boarding the car a short distance from the end, and inspecting the motors WHILE THE CURRENT IS ON THEM. The traps in the floor being raised the inspector should observe the action of the motors running together; if the car be fitted with double motors. Then each motor should be cut out, and the action of the other carefully noted. Very often the inspector finds that there is a blaze or a bubble of sparks at end of the brush, the motor apparently running all right, but a perfect ball of fire at end of brush. This is usually caused by the brush being worn away and having become fastened in the brush-holder, the spring not pushing it up against the commutator. Again, the inspector will find that there is a purplish, bluish spark which appears to follow around the commutator in the direction in which the armature is revolving; this means a broken wire or a loose connection; this motor should be *cut out at once* and the trouble remedied while in its incipiency, as oftentimes can be easily done. On cutting in one motor by itself it may be found that when the platform switch is thrown in the armature may turn a quarter turn and then remain at a standstill; this shows a short circuit in the coils of the armature and as it is always good for the repair man to know where it is, both motors should be cut in, and operated a short while together till the commutator bars are "marked" opposite the coil in question. This "marking" will generally take place in the mica just between commutator bars, it being eaten away quite rapidly by the spark which ensues on the brushes passing the short-circuited coil.

Another fault which will probably be detected before the inspector arrives is the grounding of an armature; this is usually manifested, if it is a leak more than a ground, by a violent jumping or "bucking" of the motor in question; very frequently rising up against the bottom of the car in a manner more marked and positive than agreeable. This motor should be cut out at once. Excessive sparking not following the commutator or amounting to a ball of fire beneath brush is usually caused by a dirty commutator. If very bad it should be cleaned at once; to do this a piece of No. 2 sandpaper, tacked on a block which is shown in Fig. 1, must be held tightly against the commutator while revolving, but having no brushes on the same, it being driven by the other motor. This will soon give a bright glossy color and when the brushes are reset it will be found that all trace of sparking has disappeared.

The inspector having carefully looked over the electrical conditions of the armature and brushes should then place his hand on the field coils, noting their temperature and comparing the two motors; for if one set is unduly heated and the set in the other motor is comparatively cool, one motor is doing all the work. In the same way the different coils of the individual motors should be examined to see that none is short-circuited and doing no work. After looking over the fields the inspector should turn his attention to the bearings, feeling them and seeing that they are properly lubricated. A glance at the gears is usually sufficient to satisfy him, and his inspection is properly over, unless the motor man call his attention to the lamp circuit, fuse box, or platform switches. Then the inspector should look generally over the car to see that no glasses are broken, that the windows are clean, and the car has been properly swept and cared for. Then he should fill out his inspector's blank, a form of which is given in Fig. 2. These blanks are turned in to the superintendent after the inspection for the day is over. The superintendent then issues his orders to the night inspector and cleaner who begins work on the cars when the cars are run into car house at night.

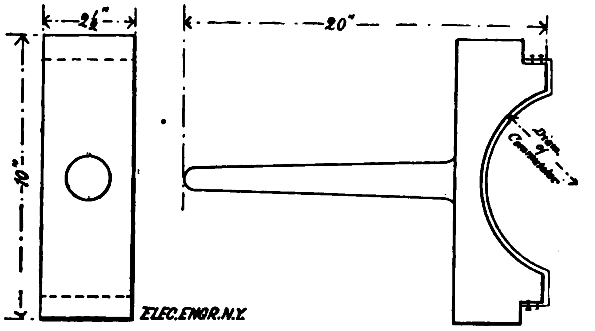


Fig. 1.—Sandpaper Block for Cleaning Commutator.

The cleaning and repairing which is necessarily done at night should be entrusted to careful, conscientious men; as this portion of the work is both tedious and monotonous. One man can thoroughly clean a car in the space of half an hour, and at least that time should be devoted to cleaning, irrespective of any small repairs on the cars. Both covers of the platform switches should be taken off and the switch nicely cleaned and polished. Then the brushes should be taken from the holders to see if they need renewing, and all the dirt and grease carefully wiped from the brush-holder, as the failure of a brush-holder causes considerable trouble sometimes. Then all the oil and grease should be wiped off of bearing and out of pans beneath the motors, and the lower and upper fields wiped dry from any flying oil. Then the orders issued by the superintendent for that car should be noted and immediately executed, so that the particular car is ready to go out in the morning with the exception of oiling. This oiling should be left till just before the car starts in the morning; for if the boxes be filled with oil or grease, being warm when they stop work, the grease will melt and run through the boxes without appreciable lubrication and be wasted. I have found grease of the type of Albany compound gave excellent results on all bearings except armature bearings, where a good engine oil answers every purpose. The night inspector should also varnish the field coils of every car under his care once a month, until a thoroughly waterproof cover is over the whole. This should be done with any good varnish, costing from $2 to $3 per gallon. When the motors are sent from the factory they only have one coat of varnish on them; after they have had repeated coats wet umbrellas running a small stream on them from the car above will have no effect whatsoever. This varnishing should be extended to the armatures also, as their life will be prolonged and dangers from burn-outs be decreased. The car should then be swept and dusted, and the windows wiped and cleaned. The dashboard and outside of car should receive special attention being wiped down with a damp sponge and dried with a chamois skin.

____
______________ '92.
Line ______________
Car number ______________
Remarks ______________
____
____

Inspector's Report '92.

Line.	Car number.	Remarks.
		Signed

Inspector.

Fig. 2.—Car Inspector's Report Blank.

This system of thorough inspection and cleaning can be carried on by small roads as well as large ones; the inspection on a small road will probably occupy some two hours and can be assigned to a man who has other duties to perform and yet has the time to attend to this one. It is much preferable to have a different inspector from the repairer and cleaner, as the work of one checks the work of the other. I have laid down the general outlines of the system, mentioning, in passing, some of the faults to which a motor is subject to, and know, if this system and practice were followed, a satisfaction and regularity of service, not reached by some roads, would be obtained.

ELECTRICITY FROM WIND POWER.

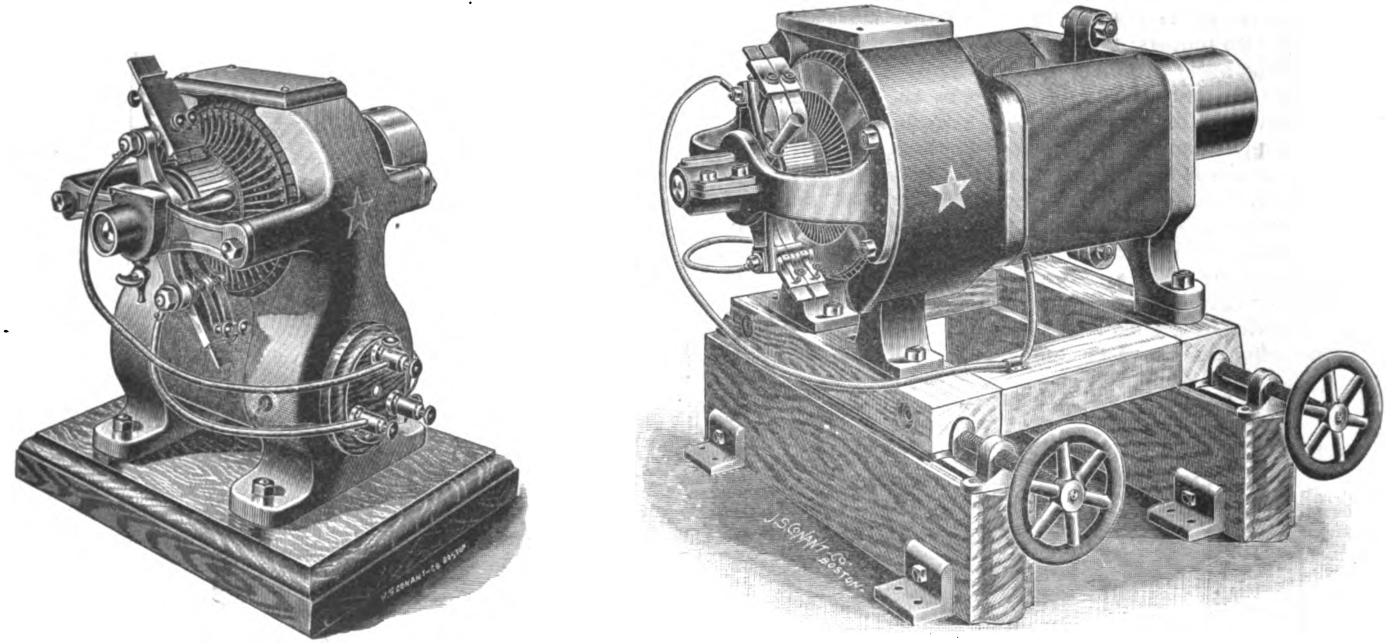
At the last meeting of the Royal Scottish Society of Arts, Prof. Blyth, of the Anderson College, Glasgow, read a paper on the "Utilization of Wind Power for the Generation of Electric Light." After alluding to his previous experiments, Prof. Blyth stated that last summer he had used a machine on the principle of the Robinson anemometer, with hollow cups, rotating horizontally. It worked satisfactorily, and in a fair wind gave out 4 E. H. P. Even in a gale it ran satisfactorily.

ELECTRIC TRACTION IN BELGIUM.

The Belgian Minister of Railways has caused a report to be drawn up on the results obtained on the electric lines at Vevey-Montreux, Moedling-Hinterbrühl, Blackpool, and other places, with the object of seeing what advantages could be obtained by the adoption of electric traction on railways.

THE JENNEY STAR MOTOR AND DYNAMO.

We illustrate in the accompanying engraving the new motor recently introduced by the Jenney Star Electric Company of New Bedford, Mass., whose office is at 196 Summer street, Boston. The engraving represents their regular 1½ h. p. motor and has several new features about it which render it interesting, and which are calculated to make a very substantial and efficient machine. The pole-pieces are of cast iron and are bolted to the horizontal wrought iron magnet. The bearings are made of brass, bolted to iron projections on the pole-pieces, and are self-oiling, having a loose ring in the shaft which revolves constantly in a bath of oil. By the arrangement of the bearings, the armature can readily be got at and removed in a very few miuutes by simply withdrawing the bolts which hold the bearings to the pole-pieces. The armature is of the Gramme ring type, but has no brass spider, being supported on fibre discs ⅜-inch thick at either side, and perforated for purposes of ventilation. The amature core is built up as usual of laminated iron. Carbon brushes are used, and there are four separate carbon blocks in each brush holder, the blocks being kept in contact with the commutator by spiral springs, the tension on which is regulated by four screws as shown. It is claimed that this type of motor will run quite cool when working up to full load. These motors are built in sizes of from ¼ to 20 h. p., and are wound for 110, 220 or 500 volts. This type is also used for incandescent dynamos up to 200 light capacity.



Figs. 1 and 2.—The Jenney Star Motor and Dynamo.

Fig. 2 shows the style of their arc light dynamo, of 10 light capacity, and of their incandescent dynamos of over 200 light capacity. The machine is, as shown, in two halves, bolted together at the pulley end, and is also provided with self-oiling bearings. The armature is of the Gramme type, and is supported in the usual way on brass spiders. The machines are well finished, and of first-class workmanship, and have attained a good reputation in actual service.

ELECTRIC MINING IN ENGLAND.

Considerable interest, says the *Newcastle Journal*, is being evinced in mining circles generally as to the result of an important electric mining installation at one of the Earl of Durham's collieries, which, when finished, will be the largest and most complete electric mining plant as yet erected in England. The operations to be effected consist of electric haulage, winding, pumping, lighting, etc.

THE ISOLATED PLANT IN THE EDISON GENERAL ELECTRIC CO.'S BUILDING, NEW YORK.

BY

Robert P. Dobbie

The new lighting plant of the Edison General Electric Co., recently installed in their own building, is probably as nearly as possible an ideal plant, and one in which everything pertaining to economy, convenience and mechanical refinement is to be found. Commencing with the boilers, there are four in all, two Heine of 125 h. p. each, and two Babcock & Wilcox of 125 h. p., aggregating 500 h. p. Any two will run the steam plant of the building. The latest devices for economy and comfort are used. Locke Bros'. damper regulator controls the draught, and all pipes, etc., are carefully covered. Two exhaust fans, each operated by a 3 h. p. motor of standard Edison type, ventilate the basement, and these are rendered more effective by partitions which cause the air to circulate on a principle similar to that used in mines to attain the same result.

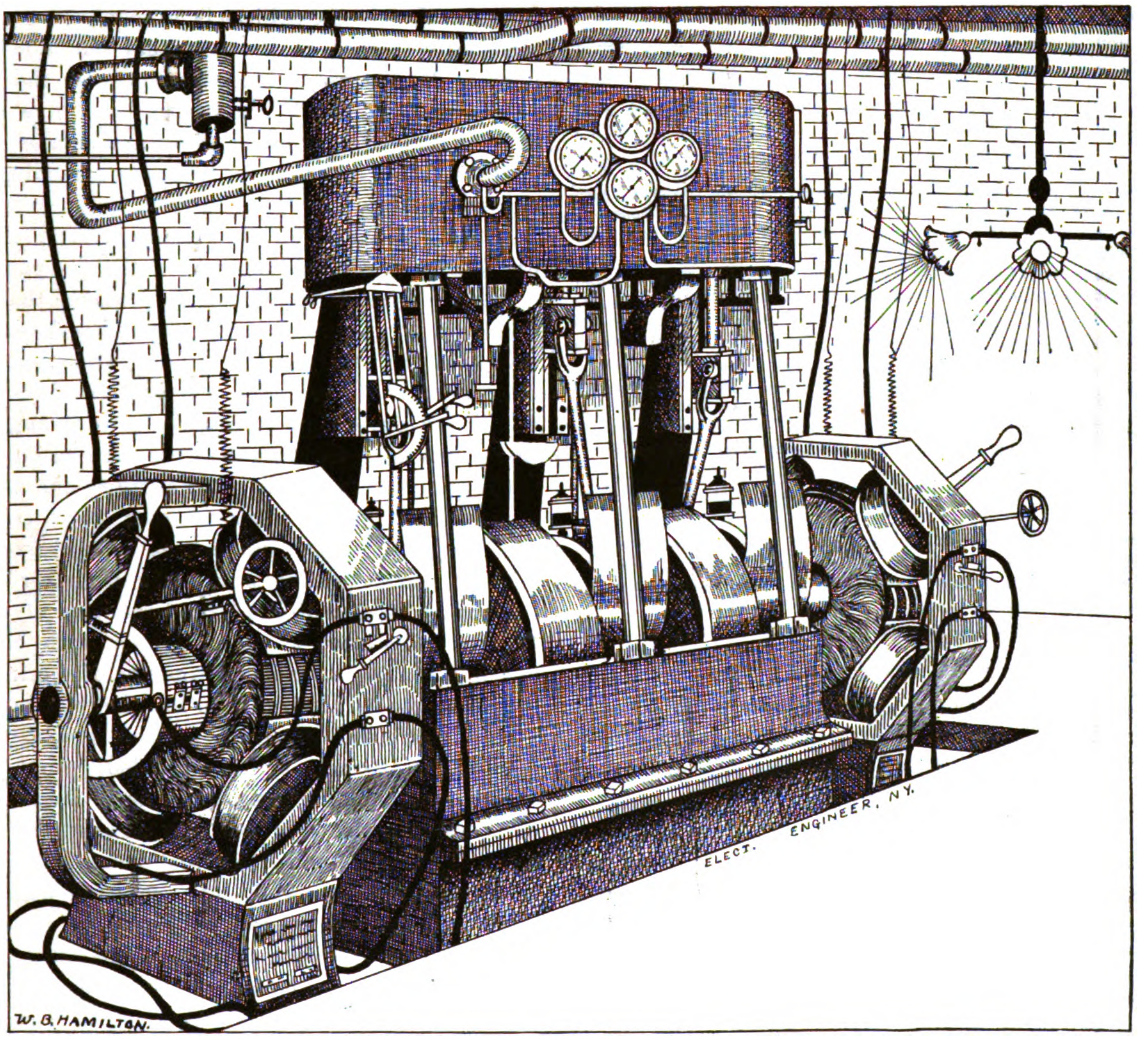
The system of duplication seen in the boilers is carried out through the whole plant, including engines, dynamos, elevator machinery, etc., down to the smallest pump.

The motive power consists of two engines each turning two 25 K. W. dynamos. The engines used are of the triple expansion inverted type so familar on the great Atlantic liners but, as may be expected in an engine for the exacting requirements of electric lighting, great attention has been paid to the question of governing. This is effected by having each eccentric operated by its own independent governor so that the point of cut-off in each cylinder is changed with the load. By this means the speed, 300 revolutions (600 feet per minute piston speed), differs less than 2 per cent when the load is changed from full load to no load.

This is not by any means a usual performance. I saw the engines running the South London Electric Railway last summer, and as they had a governor on the high pressure cylinder only, enough steam was in the receivers, valve-chests, etc., to cause the engine to race badly, if the load fell off to any great extent.

Each engine and pair of dynamos is capable of lighting the entire building which is wired on the 3-wire system throughout. Positive counters and facilities for indicator diagrams, gauges, etc., are always ready for use, and De Rycke straight line separators ensure dry steam. Unforunately, owing to locality, it was found impracticable to obtain a supply of water for condensers, but this was unavoidable. The dynamos, as will be seen, are of the multipolar Gramme ring type (4 pole). The armatures, fastened directly to each end of the crank shaft, revolve at 300 revolutions per minute, and being 2[illegible] inches in diameter, the peripheral speed is about 2,200 feet, which is very moderate, and suggests small wear and tear.

The current is taken from the commutator by four pair of brushes placed 90° apart. The field consists of a massive casting forming the yoke, while the cores over which the exciting spools are placed are castings of mild steel of such high magnetic permeability as to be practically equal to wrought iron.


ELECT. ENGINEER, N.Y.
W. B. HAMILTON.

THE EDISON 50 K. W. COMBINED ENGINE AND DYNAMO IN THE EDISON BUILDING, NEW YORK.

The method of attaching the cores to the yoke is to fit them into holes passing through the yoke. By this means an exceedingly good joint is made which is far better than merely butting the cores on a plane surface. They are compound wound with the series coils outside and are connected with equalizers in the usual way. The armature is built up of thin sheets and is mounted upon a massive bronze spider keyed to the crank shaft of the engine and having a commutator of large size. The brush-adjusting and raising devices are very complete. A worm gear arrangement moves the rocker, and, by means of a convenient lever, all brushes can be raised or lowered simultaneously. The switchboard is constructed of porous terra cotta faced with King's plaster. It presents an appearance equal to marble and can be very easily worked and repaired. Upon this are placed the numerous switches controlling dynamos and service, and a large switch connected with the Edison Illuminating Co.s' street mains renders a total shut down a very remote possibility.

THE REPULSION AND ROTATION PRODUCED BY ALTERNATING ELECTRIC CURRENTS.

In a paper on this subject, communicated to the Royal Society in December last, Mr. G. T. Walker, of Trinity College, Cambridge, gives some expressions for calculating the intensities of the force and couple respectively experienced by a ring of metal placed over, and by a ring of metal pivoted over, an alternating electromagnet. He also investigates the well-known experiment of Professor Elihu Thomson, in which a sheet of copper is placed so as to half cover an alternating magnetic pole, and a hollow copper sphere is laid upon the plate; the electromagnetic action producing a couple sufficiently powerful to overcome friction and to spin the sphere round. According to Mr. Walker, the sphere spins round in virtue of the fact that the currents induced in the copper plate "do not coincide in phase with those of the magnet, and not (as has been stated) because it acts as a screen, and renders the field unsymmetrical. Were the plate a perfect conductor it would be a perfect screen, but there would be no couple."

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VOL. XIII. NEW YORK, FEBRUARY 24, 1892. No. 199.

The class of men who were intended to be encouraged by our patent system are the most meritorious and useful ever found in any age or country. They have created all the wealth of which the law gives them the limited enjoyment.—Charles Mason.

THE BUFFALO CONVENTION.

IT might well have been supposed that coming so soon after the meeting at Montreal, the convention this week at Buffalo would find the enthusiasm and energy of the members of the National Electric Light Association flagging, so that in many respects the high level of former gatherings would hardly be attained. But the facts are quite otherwise. Not only has a good programme been prepared—already announced, with a further prospect of a trip to inspect the grand engineering work on the Niagara water-power—but the attendance already at this moment, five days before the opening, promises to be very large. Part of this is probably due to the fact that a long recess is to be taken until next year, but it must also be credited in no small measure to the deserved popularity of President Huntley and to the zeal of Secretary Porter. These two gentlemen, seconded by Mr. C. O. Baker, the master of transportation, have gone at their work in a manner beyond admiration, with the result that the central station element will be strongly represented.

That, after all, is the main thing. The Association exists for the benefit of central stations, and if the men who are interested in that very important field of work do not get together under its auspices, it fails of its purpose. Once or twice it has looked as though the Association would be lured or diverted from its fundamental objects, and each time trouble has threatened; but so long as the Association works in its chosen field, it gathers weight, influence and numbers. We know of no industrial interest more alive and progressive than that of electric light and power; and as its representative organization the Association has an indefinitely long career of usefulness before it.

COMPOUND ENGINES AND ELECTRIC LIGHT STATIONS.

THE discussion on the relative types and sizes of engines best suited for electric light stations which has been carried on in our columns has attracted general attention and has served to bring forward a number of considerations of the highest importance to central station managers. The interest taken in the subject is not confined to this country alone as evidenced by the fact that our London contemporary, *Engineering*, recently reprinted the articles by "Carleton" and Mr. W. L. Church, and in a recent issue devotes its leading editorial to a discussion of this subject. Thus, it points out, that the difficulty attending the use of non-condensing compound engines, as is well known, decreases as the initial pressure is raised, but that it does not necessarily follow that the use of the compound non-condensing engine is uneconomical, provided that the power unit is properly chosen. If the engine has the same unit provided both for the light and heavier service, waste must occur; but if the engine power be divided, as it now usually is, into several units, it is easy to arrange it so that there shall never be more than one running unloaded.

Carrying the argument still further, our contemporary expresses its doubts whether, under these circumstances, the compound engine has any advantage over the single engine in street railway work, as in the latter case it very frequently happens that a large proportion of the cars are stopped and started at once. Under such circumstances not only is there an immense amount of work to be done in setting the cars into motion but the electric motors also give a decreased efficiency, putting a vastly augmented load on the engines. This is a decidedly novel point in this controversy, and it remains to be seen whether the results of actual practice bear out this assumption. In the absence of data by which the coal consumption of two stations equipped—one with the compound engine and the other with the single—can be compared, it is as yet too early to form a definite opinion on this subject.

Engineering also points out that the reason that light loads are so detrimental to steam engine economy was admirably brought out by Mr. Willans in the discussion before the Institution of Civil Engineers on Mr. Crompton's paper on the "Generation and Distribution of Electrical Energy," read last year. Experiments show that the amount of steam used per indicated horse power in an engine regulated by a throttle valve is constant for all powers; or, in other words, it requires the same additional steam to raise the power from 20 to 30 h. p. as it does to raise it from 90 to 100 h. p.; but this does not hold good for very light powers. From the results of other tests by Prof. Kennedy and Mr. B. Donkin, Jr., *Engineering* believes that it is not far wrong in assuming that it requires 100 lbs. of coal per hour to run an 80 h. p. dynamo, light loaded. This amounts to 17 cwt. a day and does a good deal to explain the disadvantage of operating a station equipped with one or two large engines only. As a curious result of this state of affairs it is also pointed out that the reproach leveled at the advocates of the low tension distribution system against the method of working with transformers placed on the consumers' premises is largely removed, for when this plan is adopted the light load line remains constantly at a fairly high level. We must, however, remark that the remedy of one evil by the introduction of another, can hardly be considered good practice.

Our contemporary also believes that although the economy of fuel in electric light stations is of great importance, it is very possible to purchase it too dearly, and that if extra money is spent on an engine to make it more economical of fuel, then to render this cost profitable the improvement must be so great that the saving on a few hours' working per day will pay interest on the depreciation of its cost. When coal and land are dear, a small economy in the consumption with its attendant gains in boiler space and storage capacity may amount to a very respectable sum in a year. Where coal and land are cheap, money spent in complicated valve gears will, says *Engineering*, generally be wasted, and while the coal consumption in electric light stations remains at from three to six times its theoretical amount, there is plenty of scope for economy in other ways than matters of engine construction.

ELECTRIC INSTRUMENT MAKING IN AMERICA.

THE demands which the rapid growth of electric lighting made upon the manufacturers of electrical apparatus of all descriptions, especially in this country, were such that, for some time, they were unable to keep pace with it, and as a result, many of the measuring instruments employed in daily practice were, of necessity, imported from abroad. It was not to be wondered at, therefore, that the erroneous impression existed at one time that American manufacturers were unable to produce instruments of the desired quality. But if such an idea still lurks in the minds of some it must be dispelled on the perusal of the description which we give this week of one of the largest establishments in this country devoted to the manufacture of fine electrical instruments. The apparatus manufactured by Messrs. Queen & Company, both in variety and quality will, we think, stand favorable comparison with those from abroad, and they, together with other American instrument makers, deserve credit for having raised the standard of American manufactures in this department.

Advanced Central Station Engineering.

THE account we publish this week of the manner in which the Edison Illuminating Company of this city is proceeding in the design of its newest and latest station, will not fail to impress the readers with the change which is gradually taking place in the engineering of central stations. But a short while ago the installation of the enormous engines contemplated and the application of the high steam pressures to be employed, would have been considered contrary to the canons of good practice. But the adoption of the means described, by which it is hoped to attain the highest economy is, we think, not only justified but entirely feasible. Mr. John Van Vleck, the engineer of the company, is deserving of much credit in having inaugurated a practice which, we hope, will be followed by others in the equipment of electric central stations.

High-Tension Experiments.

THE interesting experiments described by Prof. Elihu Thomson in our last issue cannot have failed to arouse the interest of our readers, considering especially the fact that the apparatus employed is so simple and easily constructed. In this issue Prof. Thomson gives further details of his experiments, all of which are of an interesting character and will not fail to give stimulus to investigation in this direction.

THE HEAT RADIATION OF RAREFIED GASES UNDER THE ELECTRIC DISCHARGE.

Herr Angstrom, says *Nature*, has been lately engaged in examining with a bolometer the heat radiation of various rarefied gases under the electric discharge. He confined himself to the stronger positive light, using cylindrical glass tubes, with lateral electrodes, and rock-salt plates at the ends. An accumulator of 800 Planté elements was the source of electricity. Briefly stated, the results are these: With a given pressure the radiation is proportional to the intensity of the current. With constant current, the radiation does not vary while the pressure varies between 0.1 and 1.5mm., but at higher pressures it increases somewhat. With the same gas and pressure, the composition of the radiation is constant, and does not depend on the intensity of the current. With varying density of gas, the ratio of the intensity of radiation of shorter wave lengths to that of the whole decreases with increase of pressure. (This ratio varied, *e. g.*, from 46 to 15 per cent. in carbonic oxide between the above pressure limits.) Thus this ratio, at low pressures, reaches much higher values than in our ordinary light sources. The intensity of total radiation varies considerably in different gases, and stands in no simple relation to the molecular weight, nor to difference of potential in the gas; nor does it seem to depend on absorption of gas at ordinary pressure and temperature.

LAW OF THE MAGNETIC CIRCUIT.

IT is curious that nearly all electrical engineers think that magnetism follows Ohm's, or an analogous law. It really does not follow any such law. Ohm found by experiment that $\frac{E}{C}=R$. That is a definite law, R depending on the ratio of E and C, and not on their absolute value. The analogous magnetic "law" merely amounts to a definition. It is not a statement that the resistance is equal to the ratio of the "magneto-motive force" to the flux, as that is not the case. The resistance depends on the values as well as on the ratio of these quantities so that we have only a definition left, with no underlying law whatever. Some say, "When there is a magneto-motive force and a flux we will call their ratio the magnetic resistance." The ratio of any two quantities may be given a name, but that does not provide any analogy to Ohm's law. Of course, it must not be forgotten that current and induction are both solenoidal, but solenoidal distribution is met with in so very many branches of physics that it affords no special analogy between current and induction in particular.

THE PLANT IN THE NEW HOTEL BROEZEL, BUFFALO, N. Y.

The design and construction of isolated plants for hotels has wisely been made a specialty by some electrical engineering firms, prominent among whom may be mentioned F. P. Little & Co., of Buffalo. One of their installations of this nature was illustrated and described in The Electrical Engineer not long ago, and another shown on this page in Figs. 1, 2 and 3 will afford a good object lesson for visitors to Buffalo during the Convention week. We refer to the plant in the new Hotel Broezel. This installation comprises two Thomson-Houston spherical dynamos of a capacity of 500 and 600 lights respectively. The engines, which were also furnished and set up by F. P. Little & Co. are Rice automatic high-speed, built by the John T. Noye Manufacturing Co., of Buffalo, and are of 50 h. p. and 30 h. p. respectively. Underwood cotton leather belting is used with much satisfaction. The engines and dynamos are set on solid brick foundations, which are tied together to the floor level. The foundations extend 10 feet below the floor surface, and are built free from the foundations of the building itself. Owing to the adoption of this method no vibration is perceptible at any point in the hotel.

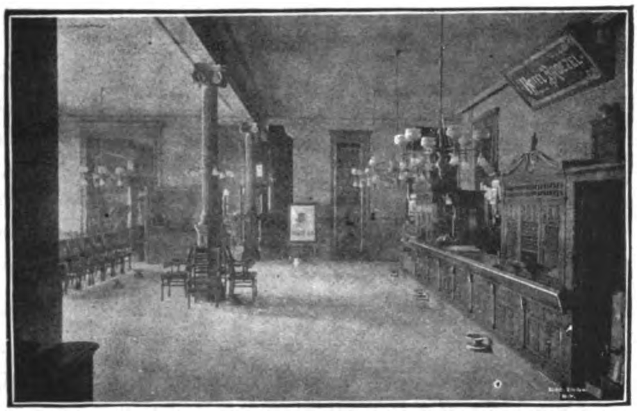


Fig. 1.—Electric Lighting in the Hotel Broezel, Buffalo, N. Y.

The building is wired for 800 lights, 500 being of 16 c. p. and 300 of 20 c. p. There are two arc lights provided for outdoor use. These are of the well-known "Mosher" type, run on the incandescent circuits, and give excellent results. The wiring is concealed throughout the building beneath the floors, and nothing but the "Grimshaw" of the New York Insulated Wire Company is used. The wiring is done in such a manner that there is practically no difference in potential between any two lights in the building. In order to avoid any risk, moreover, ample space between the wires is allowed, and no two wires of opposite polarity are anywhere nearer together than 4 inches. All safety devices are of porcelain. There is a separate cut-out for each separate group of lights; also a separate cut-out for each circuit, grouped together, placed so as to be conveniently got at on any floor. It may be noted that there is an entire absence of wires in the dynamo-room. The feed-wires are brought to the switchboard through the walls, and are not visible. The wires from the dynamos to the switchboard are carried in a conduit under the brick flooring.

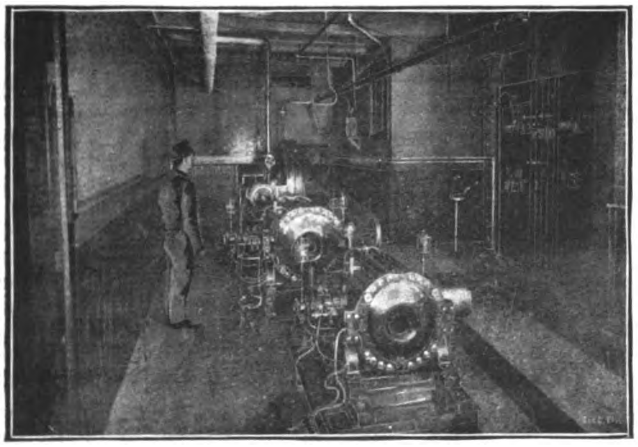


Fig. 2.—Dynamo Plant of the Hotel Broezel, Buffalo, N. Y.

Motors are becoming an essential feature of hotel plants, and this installation proves no exception, as F. P. Little & Co. have received an order for two Crocker-Wheeler motors, one of 4 h. p. and one of 2 h. p. They promise to become a strikingly valuable addition to the outfit of this altogether modern hotel, where efficiency of operation is studied equally with the comfort of the guests, and where electricity is relied upon to supply no small part of the conveniences.

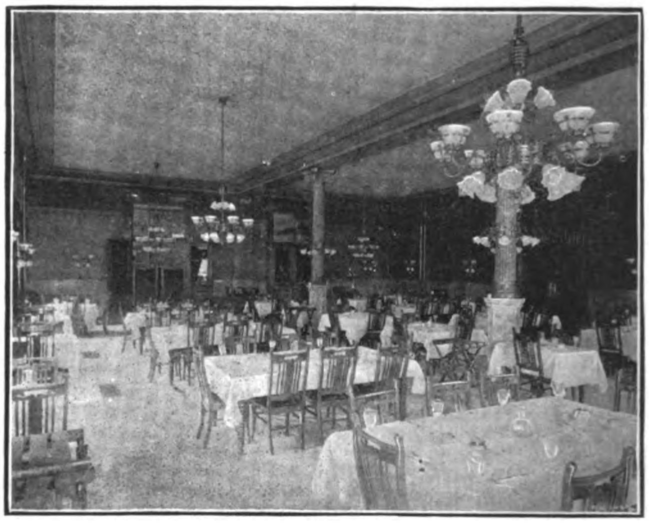


Fig. 3.—Electric Lighting in the Hotel Broezel, Buffalo, N. Y.

The firm who have put in this plant have lately been very busy in their own locality, their recent installations including a 100-light plant for the Wells Elevator at Buffalo, a plant for the W. H. Walker & Co. Building, Buffalo, and a $15,000 contract at the new Capitol, Albany. It must certainly be regarded as one of the most hopeful and encouraging features of electrical engineering that concerns of this high professional grade are establishing themselves in different localities to secure and undertake contracts requiring expert ability and skilled experience for their satisfactory execution.

COPPER.

Although the stock of copper in England and France and afloat was smaller at the end of January than it had been at the same date for three years previously, the price is considerably lower. According to Messrs. H. R. Merton & Co.'s statistics, the stock on January 31, 1892, was 57,462 tons, as against 61,396 tons in 1891, 95,714 tons in 1890, and 109,528 tons in 1889. Yet the price this year was £44 12s. 6d. per ton, as compared with £52 12s. 6d. per ton, £48 17s. 6d. per ton, and £77 10s. per ton on the same day in the three preceding years.

THE MANUFACTURE OF FINE ELECTRICAL INSTRUMENTS IN AMERICA.

BY

Jos. Wetzler.

I.

RAPID as the advance in electrical application was in this country during the last decade, it was not evenly kept up all along the line. American dynamos and lamps and motors and "systems" not only proved successful at home but were in demand abroad; yet when comparisons were made with Europe, as to fine instruments of precision, it was found that we were almost wholly dependent upon the foreigner. Some people, in fact, took it for granted that such conditions must prevail indefinitely, and that, for some occult reason, the manufacturers of England, France and Germany would long enjoy a control of the market as the result of the absence of competition. It is needless to say that these ideas, so little creditable to American skill and enterprise, have been rudely upset, and that though domestic occupation of this field has been tardy it begins to be pretty complete. In spite of the prestige and influence of long years of monopoly, and of the remarkable strides made by some of the younger builders of instruments in England, the American manufacturer has now practically made this market his own, while the profession has never had better or cheaper apparatus at its command.

It has seemed to us that this technical revolution is one worthy of a little notice at our hands, as a leading feature of contemporaneous American electrical industry; and it is but natural that the career and work of the old house of Queen & Co., of Philadelphia, should furnish us with some unusually interesting material for a brief survey of the subject. This firm serves to demonstrate the fact that age in business, contrary to the accepted laws of nature, may often be marked by growing vigor and activity; and in its special domain of work it has done not a little during the last quarter of a century to confirm the high reputation that was won for Philadelphia by Franklin in his various apparatus, by Rittenhouse with his ingenious planetarium, or by the Harrisons in expert chemistry. The history of any art is largely the history of representative individuals or firms, and the study of what has been done by them, as well as their way of doing it constitutes a valuable course of instruction.

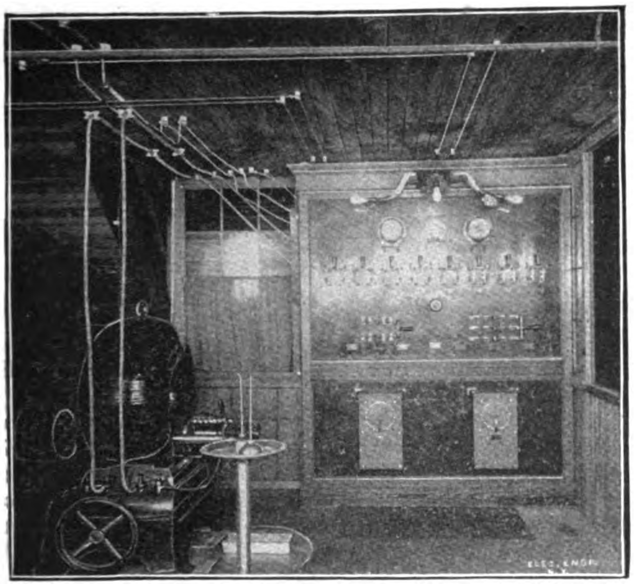


FIG. 1.—MATHER DYNAMO AND SWITCHBOARD.

In 1853 Mr. James W. Queen started an optical business at No. 924 Chestnut street, Philadelphia. The business grew very rapidly, and in 1858 Mr. Queen associated with him Mr. Samuel L. Fox. Under this new management the firm throve wonderously and extended the scope of its trade with great rapidity. In 1870, Mr. Queen retired from business, and Mr. Fox has since conducted the business alone, taking into the firm with him in 1881 his son, Mr. Edward B. Fox. Exclusively an optical business at first, the firm has gradually enlarged its scope so as to include optical instruments of all kinds, and from optical instruments to scientific instruments in general, until now the firm probably keeps in stock, handles, manufactures and sells a larger number of scientific instruments and instruments of precision than any one firm in the world.

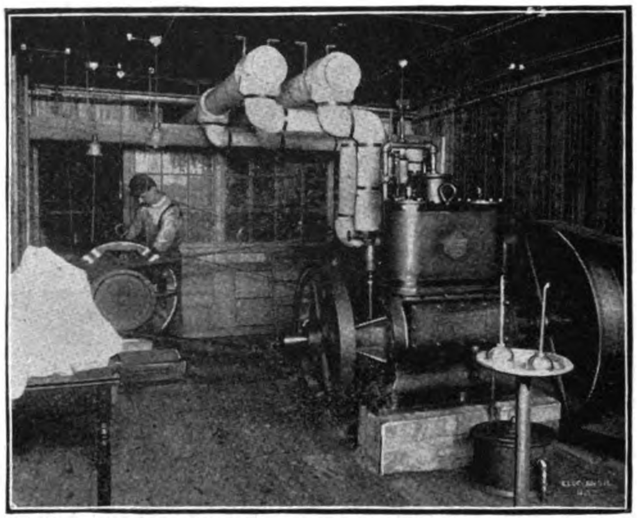


FIG. 2.—EDDY 4-POLE POWER GENERATOR.

For many years the firm was located at No. 924 Chestnut street, the site originally occupied by Mr. Queen; but the business grew with such rapidity that this building, though five stories high, exclusive of basement, proved quite insufficient for it; and a number of other buildings in the vicinity were obtained for storage and other purposes. In 1888 the building was greatly enlarged and improved and it was then hoped that sufficient space would be afforded for all. This hope, however, proved delusive, and it was deemed necessary last fall to look about for other and more commodious quarters. These were soon secured at No. 1010 Chestnut street, and extensive alterations were immediately put under way to adapt the premises to the varied needs of the business. These alterations were practically completed by the 1st of January last, and the firm moved into and took possession of its new building.

This building has a frontage of 23 feet, and has three floors and a basement extending 230 feet in depth clear through from Chestnut to Sansom streets. Another story in front and two in the rear complete the building. The total floor space in this building is 27,000 square feet, being 6,000 square feet more than in the old building at 924 Chestnut street.

II.

The new store of Messrs. Queen & Co. has been built exactly according to their designs for the express purpose of adequately accommodating the peculiar and varied interests of their vast business which is among the largest of its kind in the world. In it may be bought everything of the most remote scientific interest and importance from a magnifying glass to a steam engine.

A complete system of speaking tubes passes through the building, all tubes connecting to a central board at which an operator is stationed who makes different connections so as to render communication possible from any one part of the building to another. Each department also has a district messenger service by which messengers, police, fire or carriage service may be quickly obtained. The optical shop is connected with the repair desk of the optical deptartment by pneumatic tubes, so that repairs and work may quickly be passed to and fro. With these tubes a package may be sent from the third floor rear to the ground floor front, a distance of 325 feet and an answer received within 10 seconds.

The entire building is heated and lighted by a private plant located in the rear of the basement and is entirely satisfactory in every sense of the word. The plant consists of two 40 h. p boilers made by the Coatesville Boiler Works; injector and pumps for same; one 35 h. p. Westinghouse engine; one 25 h. p. Westinghouse engine.

The heating is done by steam at a pressure of but 3 lbs. during the coldest weather and the plant was put in by the Onderdonk Steam Heating and Ventilating Co. of No. 19 North Sixth street, Philadelphia. A Spencer damper regulator is used, and by its means the steam pressure is kept constant within a variation of but ½ lb. The entire plant was put in under the supervision of M. R. Muckle & Co., engineers and contractors, of Philadelphia, and was planned by Mr. M. R. Muckle and Mr. E. G. Willyoung, of Queen & Co.

The dynamos are a 400 light Mather 110 volt machine and a 20 h. p. 220 volt Mather 4-pole generator; the 220 volt generator furnishes power to the front passenger elevator which is run by an Eddy motor, and also to the optical shop on the third floor rear, where there is installed a 10 h. p., Mather 4-pole motor. Our engraving, Fig. 1, shows the Mather machine together with the switchboard, which was specially designed so that the plant can be directly connected to the Edison street mains by throwing over a switch. Fig. 2 shows one of the Westinghouse engines driving the Mather 4-pole generator.

The wiring throughout the building, as also the actual installing of the engine and dynamo plant, was done by Messrs. W. S. Griffiths & Co., the Mather agents for Philadelphia. The rear elevator is run direct from one of the engines, both being very close to each other.

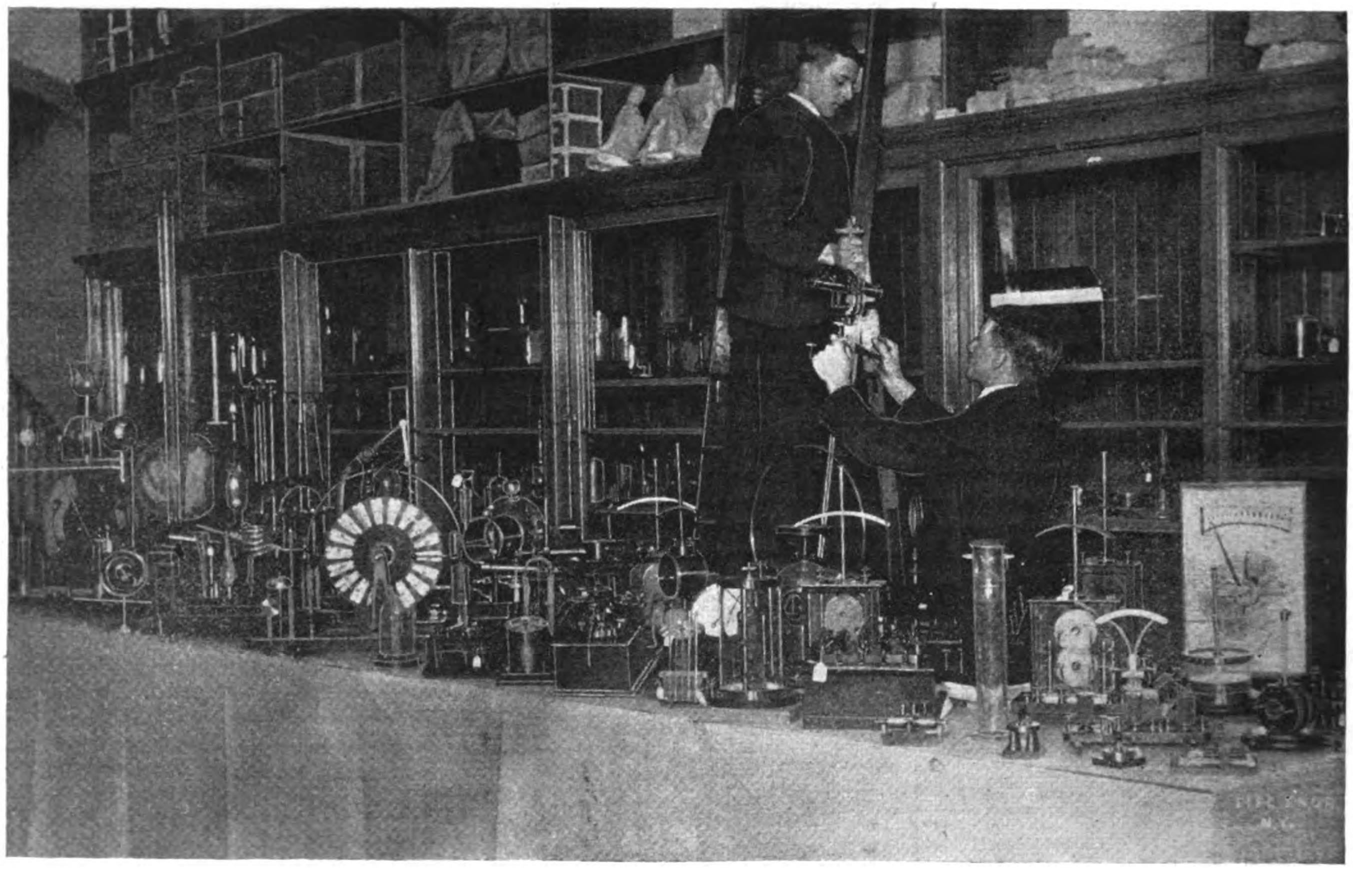


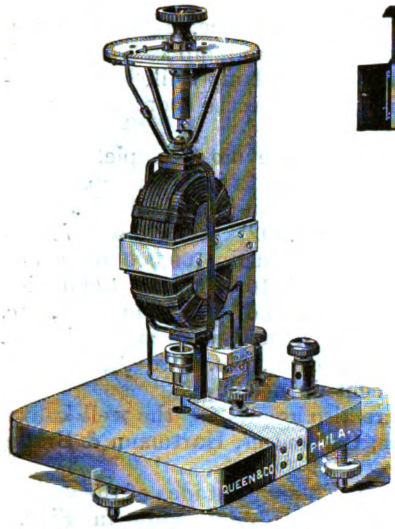
FIG. 3.—A VIEW IN THE ELECTRICAL INSTRUMENT DEPARTMENT.

III.

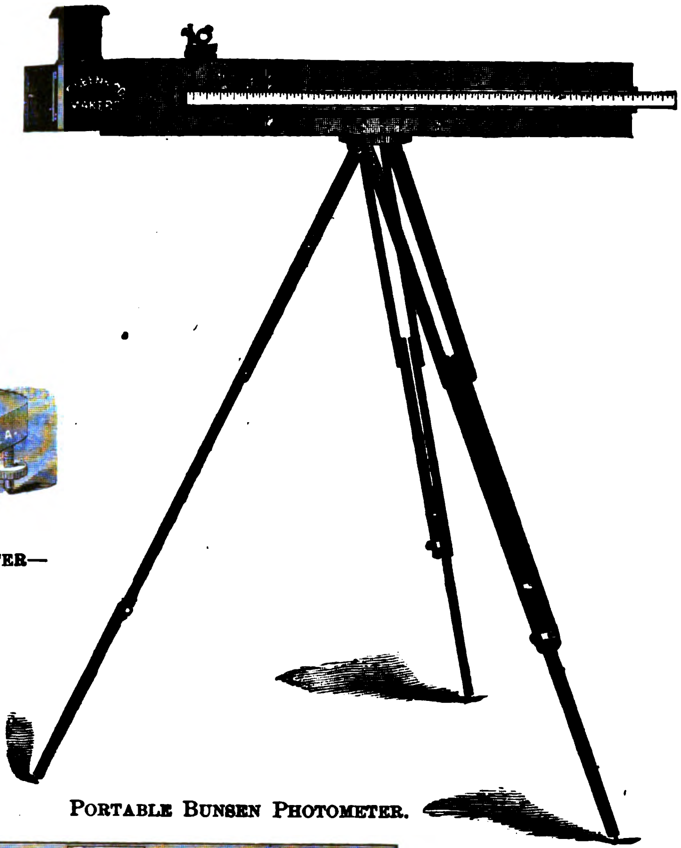
There are now seven departments to this immense establishment, each under the management of men who have had special training and experience in the particular line under their charge.

These departments are: 1. Optical. 2. Engineering and mathematical instruments. 3. Microscopic. 4. *Electrical Test Instruments;* Electrical and philosophical instruments and apparatus. 5. Magic lanterns, stereopticons, astronomical telescopes, etc. 6. Meteorological instruments. 7. Photographic apparatus and accessories. 8. Chemical.

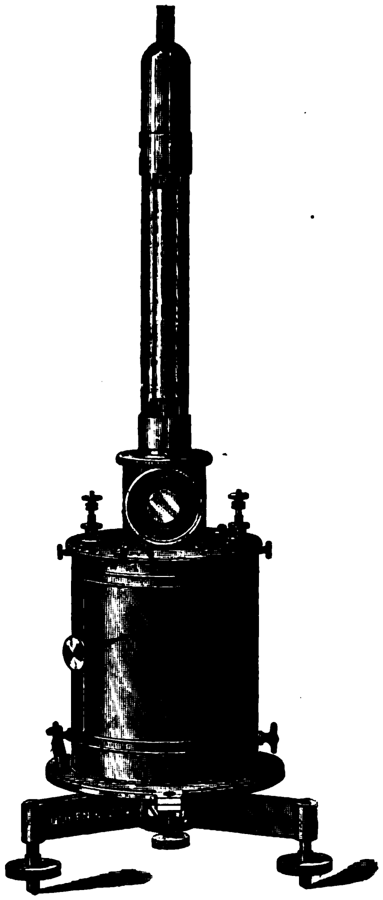
The limits of this article prevent us from entering into the details of all these departments which could be made the subject of several interesting volumes, but a good idea of the varied character of the apparatus handled by Messrs. Queen & Co. can be gathered from the bound catalogue of the firm combining the catalogues of all the departments. This is probably the largest catalogue published by any house in the world. It has over 1,200 pages and lists over 30,000 distinct articles. When it is remembered that



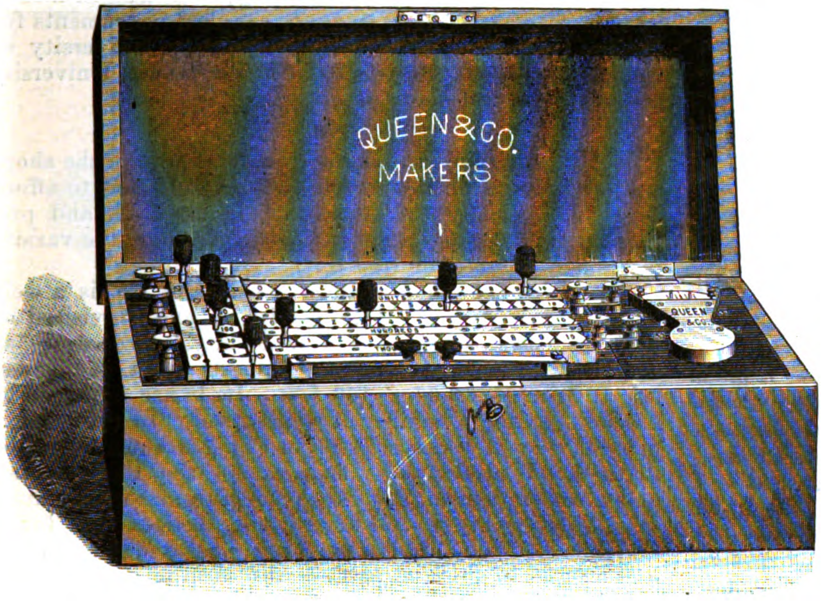
SIEMENS ELECTRO-DYNAMOMETER—
"OPEN FORM."



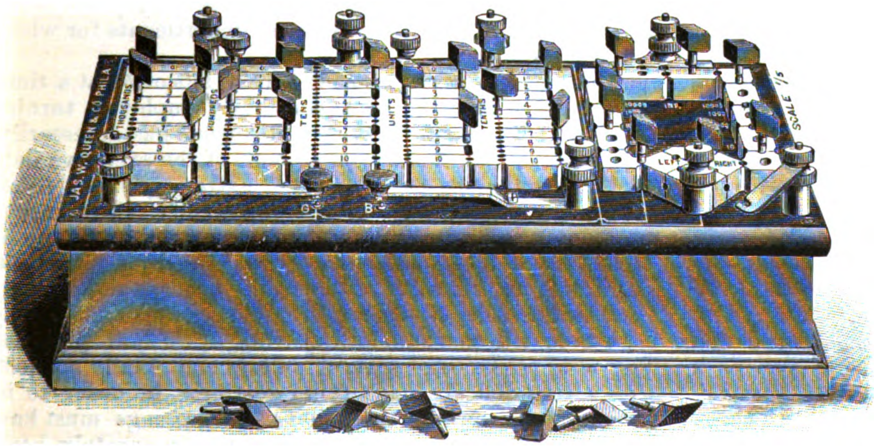
PORTABLE BUNSEN PHOTOMETER.



MASCART ELECTROMETER.

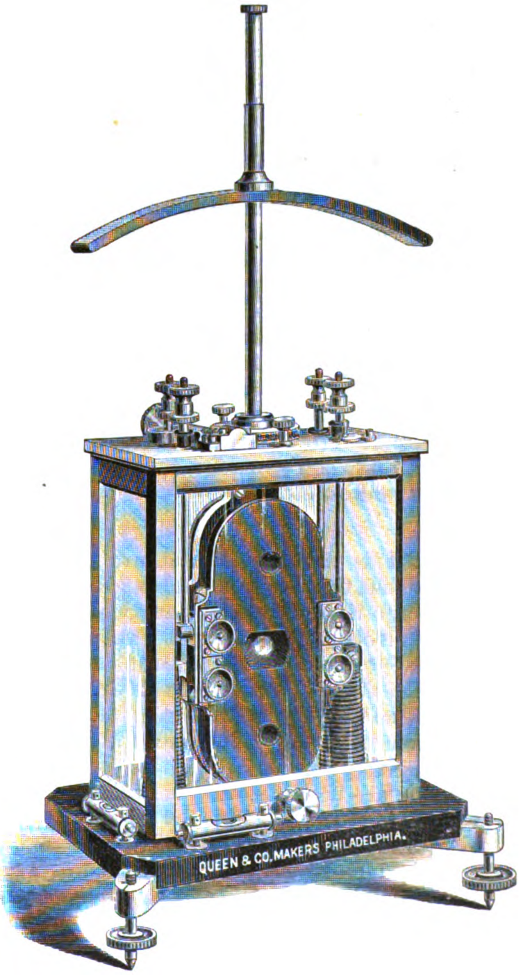


PORTABLE TESTING AND RESISTANCE SET.



STANDARD RESISTANCE BOX AND WHEATSTONE BRIDGE, No. 1.

FIG. 4.


QUEEN & CO. MAKERS PHILADELPHIA.

NEW THOMSON GALVANOMETER.

almost every one of these articles is of scientific importance, some idea of the vast scope of the business may be obtained.

We must, however, confine ourselves to the Electrical Instrument Department, one of the largest and most flourishing of the establishment, and one which is known all over the country wherever fine and accurate instruments are used.

IV.

For purposes of management the work of the Electrical Instrument Department has been divided into three parts, namely, General Oversight and Finance, Correspondence and Advertising, and Manufacturing.

Mr. Wm. Biddle, the business man of the department, has been with Messrs. Queen & Co. for many years and has in succession filled most of the various positions in the department and has had, therefore, a large experience. His brother, Mr. Jas. G. Biddle has also been with the firm for a number of years and has made a special study of the marketing of scientific instruments and apparatus; all quotations are made by him, a work of no small magnitude when it is remembered that the number of distinct pieces catalogued by this department alone is over 4,000, while at least 2,500 pieces made by other makers (most of them foreign), and none of these pieces duplicates, are sold every year. To assist in the work of correspondence with foreign makers a translating clerk is attached to this department. Mr. Jas. Biddle also has charge of the advertising of the department.

The manufacturing of this department has been for the past two years in charge of Mr. Elmer G. Willyoung, a graduate of Michigan University, and formerly assistant in physics and electrical engineering in that institution. The manufacturing of this department embraces both that of electrical instruments and apparatus and of physical apparatus. This department publishes the largest physical apparatus catalogue that is issued in America, about 4,000 pieces being listed, most of them being manufactured in the shop of the firm.

All the instruments and apparatus manufactured by this department are designed in the draughting-rooms of the department, skillful draughtsmen being employed. To supervise the manufacturing of physical apparatus as distinguished from electrical, Mr. Willyoung has an assistant who gives his whole time to the work.

This department has dealings with nearly every college in the country and with a majority of the schools. Probably three-fourths of all the scientific instruments and apparatus sold to schools and colleges for the purposes of class or laboratory work in physics goes from Department 4 of Queen & Co. Among the instruments manufactured and sold may be mentioned air pumps, sirens for determining the rate of vibration of tuning forks and other musical bodies, Atwood's machines for determining the laws of falling bodies, etc.

V.

But it is in the manufacture of fine electrical instruments that this department has grown most rapidly. Three years ago it was thought practically impossible to secure a good electrical instrument except from abroad. Now it can be positively asserted that most of the instruments made in the shops of Queen & Co. are fully as good as any for the same purpose that can be obtained from English or continental makers if, indeed, they are not superior. Among the leading specialties for which Queen & Co. are famous are their Cardew voltmeters, the American patents for which are owned by them; portable testing and resistance sets; standard resistance sets, etc.

This department also manufactures Thomson tripod and double-coil reflecting astatic galvanometers, as well as a large number of other types of galvanometers, together with the telescopes, scales and lamps to be used with them. Among the products of the firm, also, are large photometers for either arc or incandescent measurements and fitted with all appliances, such as candle balance, Methven screen, socket for using a calibrated electric lamp as a standard, socket for carrying an incandescent lamp while being measured so as to present it to the "grease spot" at any desired angle, etc.

In addition to these, probably the most complete line of standard resistance boxes in the world is manufactured by Messrs. Queen & Co., including the Standard No. 1 Set of Prof. Anthony's design, "P. O." pattern of Wheatstone bridge and rheostat combined, 100,000 ohm box (long) in 10 sections, subdivided 10,000 and 1,000 ohm boxes, Standard 1 ohm, $\frac{1}{10}$ ohm, and $\frac{1}{100}$, ohm coils, etc. All of these are wound with platinoid wire and adjusted, the No. 1 from $\frac{1}{50}$ to $\frac{1}{100}$ per cent., No. 2 to $\frac{1}{20}$, and the others from $\frac{1}{10}$ to $\frac{1}{20}$ per cent. in accuracy.

Messrs. Queen & Co. are also agents for the well-known foreign makers, Edelmann, Carpentier, Hartmann & Braun, Sir Wm. Thomson, etc.

Our illustration, Fig. 3, gives but a faint idea of the variety of apparatus handled in this department, while in Figs. 4 and 5 there are illustrated some of the more important of the instruments above referred to which afford an interesting object lesson in electrical measuring instruments, embracing, as they do, instruments for the most refined measurements as well as for every-day commercial work.

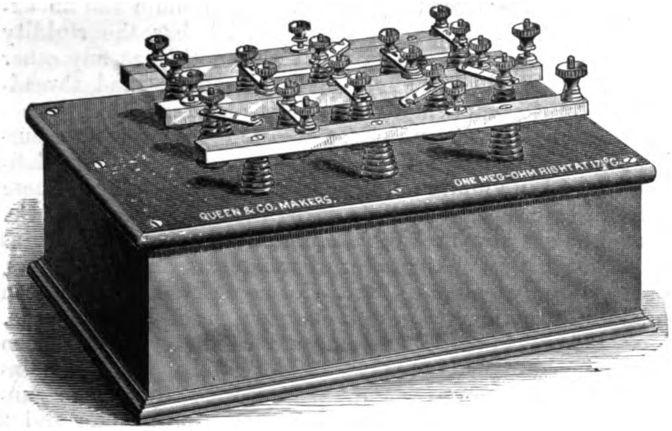
During the past few years Messrs. Queen & Co. have equipped most of the new electrical laboratories which have gone up about the country. The new electrical laboratory of Princeton College, built about three years ago, was equipped with over $5,000 worth of the finest electrical instruments by Queen & Co. A large part of the equipment of the Massachusetts Institute of Technology was also furnished by this firm, who have similarly supplied instruments for Purdue University, Ohio State University, University of Michigan, Cornell, University of Pennsylvania, University of California, and many others.

VI.

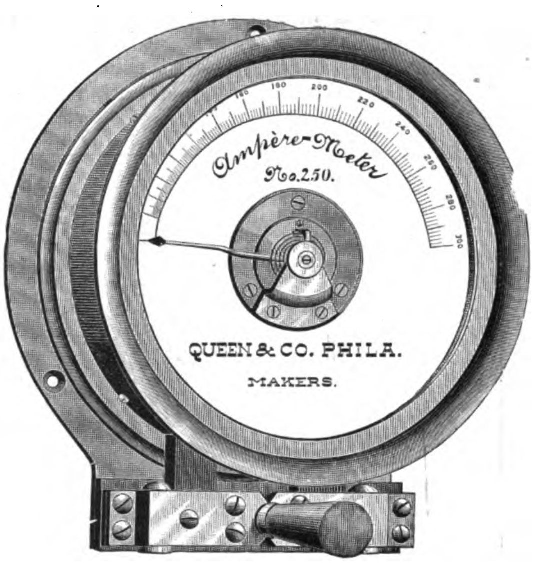
We propose, now, to take our readers through the shops and laboratories of Messrs. Queen & Co. and thus to afford them an opportunity of inspecting the methods and processes which are applied in the manufacture of the various instruments above referred to.

The instrument shop of Messrs. Queen & Co. is a well-known establishment of Philadelphia, and is visited by most scientists coming to or near the city. It occupies an entire floor at Nos. 817 and 819 Filbert street, and covering a floor space 60 x 150 feet. In in are employed 70 hands including a number of apprentices. In this shop, a general view of which is given in Fig. 7, are manufactured all the goods made by the firm except the thermometers and spectacle lenses. The shop is equipped with all kinds of special machinery and labor-saving devices. As far as possible the hands in this shop are separated into groups and located in different parts of the shop to conform with the division into departments for which they are executing work; this has the advantage of keeping work of the same nature together and of making it more readily accessible for inspection by the heads of those departments for whom it is being done.

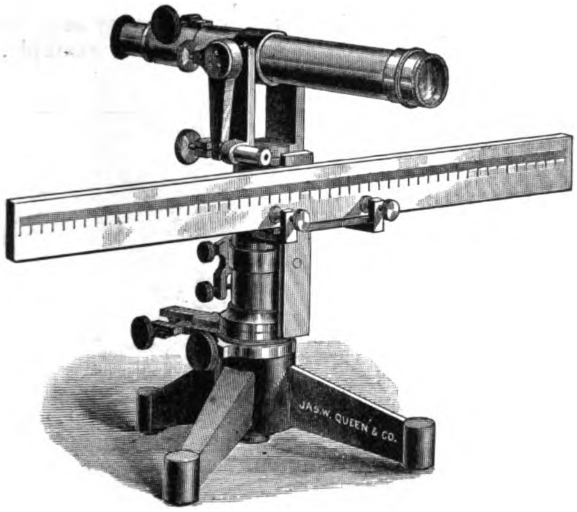
Cardew voltmeters are made here in lots of 50 at a time, and one set of men is kept constantly employed turning them out. The work on these instruments has, necessarily, to be of a very high order on account of the excessive delicacy of the moving parts and the extremely small forces involved in the working of the instrument. The instrument depends for its action, as is well known, on the linear expansion of a very thin wire when heated by a current. Depending upon heat effect alone, the instrument is equally valuable for either direct or alternating currents and has long been accepted as a standard instrument for both purposes. This wire passes over several pulleys and finally connects with a very delicate magnifying gearing. In order to insure accurate working the pulleys and gearings must have finely polished pinions and the jewels be accurately bored and set. The gear teeth, jewels and pinions are all carefully


QUEEN & CO. MAKERS.
ONE MEG-OHM RIGHT AT 17°C.

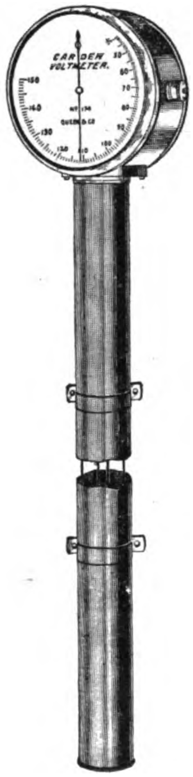
STANDARD MEGOHM BOX.


Ampère-Meter
No. 250.
QUEEN & CO. PHILA.
MAKERS.

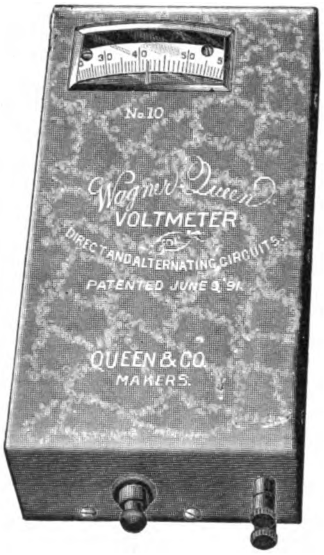
MAGNETIC VANE AMMETER.


JAS. W. QUEEN & CO.

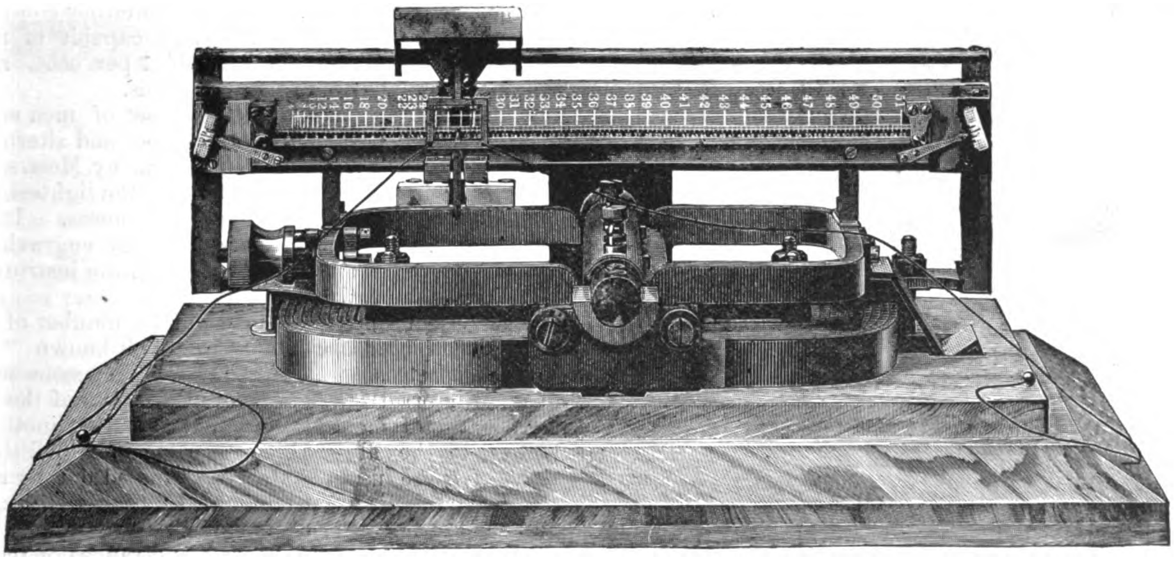
READING TELESCOPE.



CARDEW VOLTMETER.



WAGNER-QUEEN VOLTMETER.



THOMSON STANDARD HEKTO-AMPERE BALANCE.

FIG. 5.

examined with a magnifying glass before using and the slightest irregularity or roughness is the cause of their rejection. All the other parts of this instrument, also, are made exactly to gauge and hence all parts of completed instruments are mutually interchangeable. Wherever possible, the smaller parts are stamped out with very accuately cut steel dies.

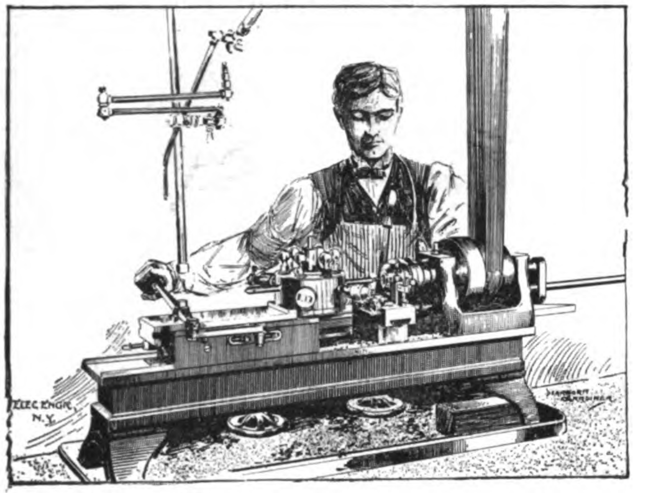

ELEC. ENGR. N.Y.

FIG. 9.—MAKING BINDING POSTS IN SCREW MACHINE.

In making these instruments Queen & Co. have greatly improved upon them as made by foreign makers, both in appearance and quality. One very valuable modification which will be appreciated by all, is the great diminution of weight. In a lot of instruments just completed by Messrs. Queen & Co. almost the entire instrument is made of aluminum, with the result that the weight of the instrument is but 4 lbs. as against 7½ lbs. in the English make. The effect is, also, to considerably add to the beauty of the instrument.

VII.

The adoption of aluminum in the construction of electrical instruments may be said to constitute one of the most important advances in this art made in recent years. In this direction Messrs. Queen & Co. have probably accomplished as much as any other firm, if not more, in the determination of certain of the more important mechanical properties of aluminum and its alloys. They have expended a great deal of money in working out the practical problems connected with its use and have attained results amply satisfactory. As a result, they can now cast an alloy containing over 85 per cent. of aluminum and an exceedingly small amount of copper which has the rigidity of cast brass, turns as easily and smoothly as any other metal, and in which the most delicate tapping and threading can be accomplished with entire success.

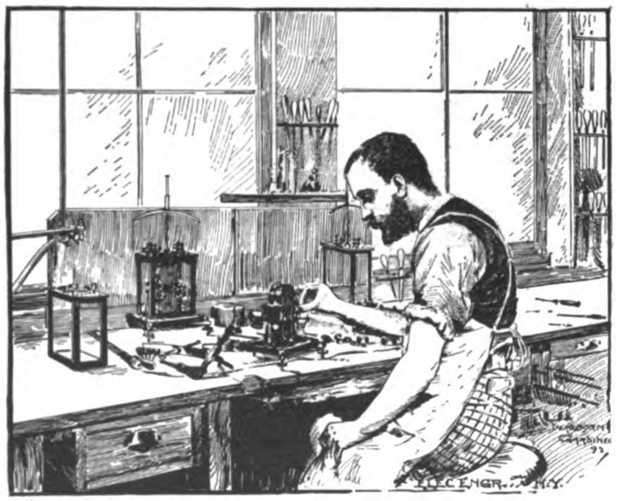

ELEC. ENGR. N.Y.

FIG. 6.—ASSEMBLING A THOMSON DOUBLE COIL GALVANOMETER.

Many have given up in despair all hopes of ever securing a hard, firm casting; others, again, of ever putting a delicate thread in aluminum on account of its porosity. These difficulties are now so lightly regarded by Queen & Co. that they are now making aluminum transits regularly as a market article. A number of ammeters and voltmeters, parts of galvanometers and electrometers have also been made of the metal as well as portions of leveling rods, etc. Opera glasses with aluminum cases have also been made and are very popular. A method has also been invented in the shop of Messrs. Queen & Co. by which seamless aluminum tubing up to 2½ inches in diameter and 3 feet long can be easily obtained; this, up to two months ago, had been thought quite impossible, and is still thought to be so by many.

VIII.

In another part of the shop Queen & Co.'s well-known "Portable Testing and Resistance Sets" are made; these, also are made in lots of fifty at a time, special tools having been made for many of their parts so that they may be turned out quickly, accurately and cheaply. For example, all the hexagonal blocks on the top of the set are made by one set of men, all the rubber plugs by another, the binding posts by another, the rubber tops are cut and polished by another, etc. These sets are sold either combined with a galvanometer, or without, and are capable of measuring with an error of but one-fifth of 1 per cent. resistances ranging from $\frac{1}{10}$ ohm to 10 megohms.

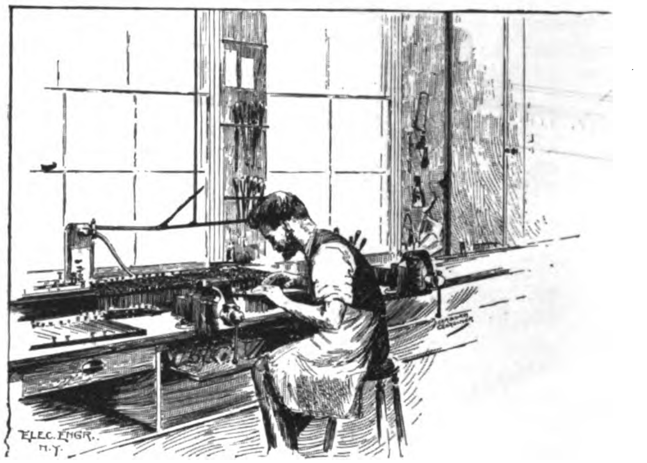

ELEC. ENGR. N.Y.

FIG. 6A.—ASSEMBLING PORTABLE TESTING SETS.

A little further along we find a set of men engaged in making the new Wagner-Queen direct and alternating current voltmeter, recently brought out by Messrs. Queen & Co. This instrument is said to be the lightest voltmeter in the world, weighing but 22 ounces. It is made almost entirely of aluminum, and the engraving, Fig. 8 shows it in the course of assembling, the instrument complete being shown in Fig. 5 group.

Still a little further along we find a number of workmen engaged in manufacturing the well-known "Magnetic Vane Ammeters and Voltmeters." The same subdivision of labor is practised here as in other parts of the shop, one man, or set of men, making all the backs, another all the bodies, another all the binding posts, etc. All the smaller parts of these instruments are stamped out by accurately cut dies and heavy machinery, so that all parts are exactly alike and inter-changeable.

Twenty-three different forms and ranges of these instruments are catalogued, the instruments being made in several sizes for either large or small plants and both in brass and iron. Ammeters of this type can readily be made to include as high a range as 2,000 or 3,000 amperes, and volmeters as high as desired. These instruments have come into very extensive use; they are great favorites, especially on ship-board and form an essential part of the magnificent plants put in by the Edison Company on the Sound line of steamers.

In the manufacture of fine galvanometers, Queen & Co. believe they have attained a success in two years fully equal to that secured in tens of years by the best European and English makers. The Thomson double-coil and tripod galvanometers, in particular, manufactured by them, they believe to be superior to any other made anywhere in the world, in regard to beauty of finish, high insulation and great sensibility. These instruments are now made in several different ranges so as to be suitable for any kind of high grade work. A large variety of other forms of galvanometers is also made in this shop, both for commercial and for laboratory work, and embracing the reflecting, ballistic, dead beat, etc., types. A large quantity of control and reversing keys of orthodox and special design for all kinds of testing and cable work are also made here. Figs. 6 and 6A show two views in the assembling department.

IX.

Among the special machines used by Messrs. Queen & Co. in their manufacturing department we find milling machines, punching machines, shapers, etc. The screw machines are very interesting, these being largely automatic in their action and used in the manufacture of binding posts, screws, etc. The largest of the machines now owned by Queen & Co. and illustrated in Fig. 9, takes rod up to $\frac{3}{4}$-inch in diameter. All that is necessary in this machine is to keep it supplied with rod, special tools shaping the post or screw, drilling and tapping it, cutting it off, etc. in quick succession; on one of these machines several thousand complete binding posts may be made in one day.

In the rear of the shop will be found the lens grinding and glass cutting machinery which is also very interesting. Here bevel edged glasses for "Magnetic Vane" and Cardew instruments are made; small lenses for magnifying scale readings are ground, shades are cut, etc. An interesting process is the cutting of holes in the top or sides of bell shades; holes can be cut in any portion of these shades up to 2 inches in diameter, and this, no matter upon what part of the shade or what its curvature.

In the rear of the shop also is one of the large dividing engines, a view of which is given in Fig. 10. On this engine are graduated many of the glass or metal scales used on various instruments; divisions can be placed accurately at any distance apart on circles or parts of circles up to 18 inches in diameter. A second dividing engine of a much finer kind is used on the best grade of graduating; this engine is kept in a special room built for it on top of the instrument shop, the adjuster working here alone, perfectly undisturbed. This engine will graduate circles up to 36 inches in diameter. In this room the final adjustments are made of the finer transits, points for setting being located over a mile away in each direction.

Attached to the instrument shop is the foundry. This occupies the bottom floor of a small detached building just back of the main shop while the pattern-room is located just above. Expert molders are employed in this foundry, in which are made nothing but the finest castings, all rough iron castings being obtained from outside; aluminum and aluminum alloys, phosphor bronze, brass, etc., are all cast here.

Queen & Co. are now making extensive alterations on the floor just above the foundry for the purpose of placing

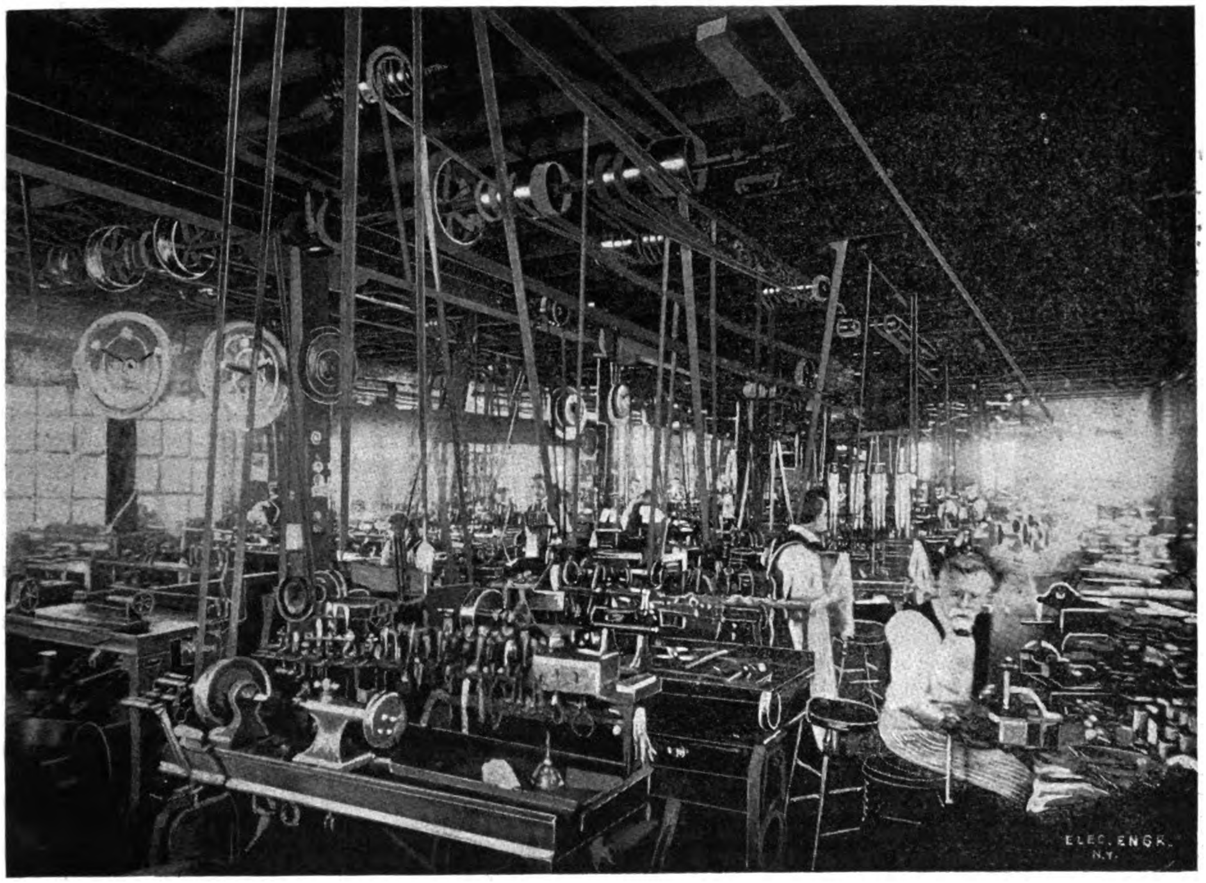


FIG. 7.—GENERAL VIEW OF MESSRS. QUEEN & CO.'S INSTRUMENT SHOP, FILBERT ST., PHILADELPHIA.

there, their cabinet and wood working shop, and will equip it with the most improved wood working machinery.

X.

An important part of electrical instrument manufacturing is the testing and calibration, etc., including special tests of wire for insulation and conductivity; tests of batteries for efficiency, output, etc.; tests of galvanometers for sensibility; experimental work on new instruments; calibration and standardization of standard and commercial ammeters and voltmeters; adjustment of standard resistance boxes and coils, etc.

Realizing the necessity for work of this kind, Messrs. Queen & Co., about two years ago, at just about the time they began to actively push their electrical business, made a contract with the Mather Electric Co. of Manchester, Conn., which had just secured the services of Prof. Wm. A. Anthony, then leaving Cornell University, as electrician, by which the Mather Co. was to do all the finer standardizing and adjusting for them under the supervision of Prof. Anthony. Operating under this contract the business rapidly developed until it necessitated almost the running of a special and separate plant by the Mather Co. for the doing of this work. Under this contract Prof. Anthony designed several new instruments, which were manufactured by Queen & Co. and adjusted by him.

As time went on the business assumed such proportions that it seemed to be very desirable that it should be concentrated and done under one management, especially as the growing business of the Mather Co. demanded more and more of Prof. Anthony's time. It was therefore decided that the contract, expiring Jan. 1st, 1892, should be discontinued on that date. Hence Messrs. Queen & Co. immediately set to work to equip for themselves a laboratory suitable and adequate for their work. It should be stated here that during 1891 a large part of Messrs. Queen & Co.'s work was done by themselves at their old place, No. 924 Chestnut street, the Mather's Co.'s facilities, owing to other calls, not being sufficient to turn out the large quantity of work needed. This work included the adjusting and standardizing of Cardew voltmeters, of school resistance sets, galvanometers, etc.

Looking about for larger facilities, it was decided to be quite impossible to secure the requisite stability and freedom from magnetic disturbance within the city proper. After considerable prospecting a property was found at Ardmore, Pa., which seemed to answer all requirements.

XI.

Ardmore is ten miles out from Philadelphia, on the main line of the Pennsylvania R. R. to Pittsburgh; it is just below Haverford College and two stations east of Bryn Mawr. The property secured by Messrs. Queen & Co. is 50 feet wide and 275 feet deep and has upon it a large frame house containing ten rooms, Fig. 11. This house has been fitted up to do all but the very highest grade of work; for the latter a separate magnetic house was built, which will be described later.

In the house the office is the second story front. Here are situated the desks of the electrician and of the bookkeeper. A fine reference library of the best American, English, French and German works on electricity and cognate science, dictionaries, etc., is here for the use of the staff. There is also a table upon which are the current numbers of the principal American and foreign periodicals. The laboratory staff is encouraged to read these books and periodicals, and each member is allowed to take not over two of them home overnight at any time. All completed work is brought to this office for inspection and approval before shipment.

In the second story front is also the draughting-room. In this room is a large case in which are kept the working drawings used in construction; these drawings, hundreds in number, are all carefully classified and arranged so that any one can be immediately referred to without the slightest loss of time. Four draughtsmen are employed continually, and even then the work can hardly be done rapidly enough. In this room is done all the scale draughting, original designing, etc., and the making of working drawings and tracings.

Just back of the draughting-room is one of the inside testing-rooms. This room, illustrated in Fig. 11, is fitted up with a complete equipment of instruments for the measurement of resistance and the adjustment of resistance coils and boxes; several galvanometers are used, of various resistances and of the D'Arsonval type. Almost all the galvanometers used on the premises are of this kind, it being possible to make them exceedingly sensitive and yet practically uninfluenced by magnetic disturbances or ordinary mechanical vibration, while their dead-beat qualities render them very quick in use. In addition to the testing instruments is a work table well equipped with small tools, etc.

XII.

Stepping across the hall we come to the winding-room and upper workroom. In this room is done all of the winding of spools needed for the "Portable Testing and Resistance Sets." To wind spools for these sets requires the steady labor of one man. A small lathe is used for winding, run by a 110 volt Perret $\frac{1}{8}$ h. p. motor; a special resistance box is used by means of which the speed of the motor is under perfect control and may be varied from one revolution to fifty per second; with this box, also, the direction of motion can be changed at will.

The winding of these coils, which is illustrated in Fig. 12, is done very systematically and can be done with an exceedingly small waste. Before beginning to wind a lot of coils of any kind, each spool of wire, as it comes from the makers, is tested in order to see how many centimetres run to the ohm. The amount needed to make up a given resistance is then calculated and about $1\frac{1}{2}$ per cent. added. One half of this amount is then wound off on a reel exactly one meter in circumference and placed behind the winder as shown in the engraving. The other half is then wound off on the reel at the side of the first. The reel being about two feet long there are usually several dozen pairs of such lengths wound off; this supplies enough wire for as many spools as there are pairs.

The outside ends of two adjacent wires are now taken and carried through two small holes in one end of the spool and the two wires wound upon the spool (which has been chucked in the lathe) side by side; when, finally, the two ends are reached they are soldered together. The other two ends are then clamped in the testing bridge and the resistance of the spool measured. The adjustment is secured by altering the position of the joint; if the resistance is too high a little solder is run between the wires so as to make the total joint length shorter. By testing every tenth spool or so, to allow for any non-homogeneity of the wire, the spools can be so closely adjusted in the winding that not over $1\frac{1}{2}$ per cent. of the wire is lost.

Part of this room, also, is used as a workshop for the upper floor. A fine Hill instrument lathe with divided head stock, taper cutting attachment, slide rest, etc., complete, is placed here with a complete set of metal and wood turning tools. A heavy carpenter bench fully equipped with carpenters' and cabinet makers' tools allows the doing of any incidental woodwork which may be necessary.

Just across the hall from this room is the other inside testing-room. This latter room is equipped very much as is the first testing-room described, except that the instruments are of a somewhat higher grade for the doing of a somewhat better class of work. In addition to the apparatus for resistance adjusting there is, in this room, a switchboard connected with the electrical system of the house,

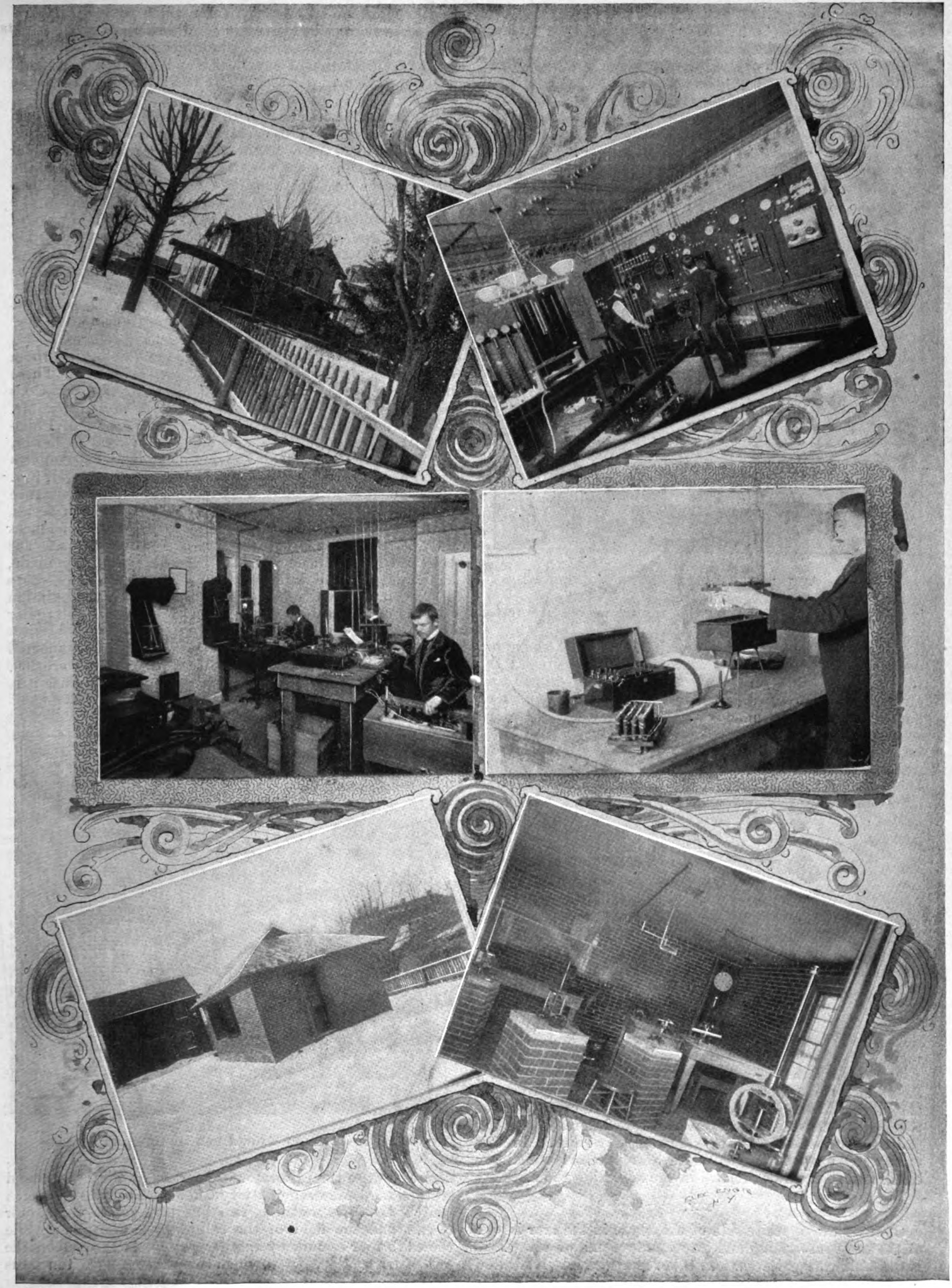


FIG. 11.—ELECTRICAL STANDARDIZING LABORATORY AND MAGNETIC ROOM OF MESSRS. QUEEN & CO., AT ARDMORE, PA.

designed for the calibration of low range ammeters and voltmeters and any other odd uses requiring E. M. F. or current. This board gives voltages from 0 to 100 and currents from 0 to 100 amperes. In this room, also are wound all the high grade galvanometers, ammeters, shunts, etc., which are then taken to the magnetic-room for careful testing. All the electro-dynamometers made are also standardized here. In this room also the wound spools are tested and put into place in the resistance boxes.

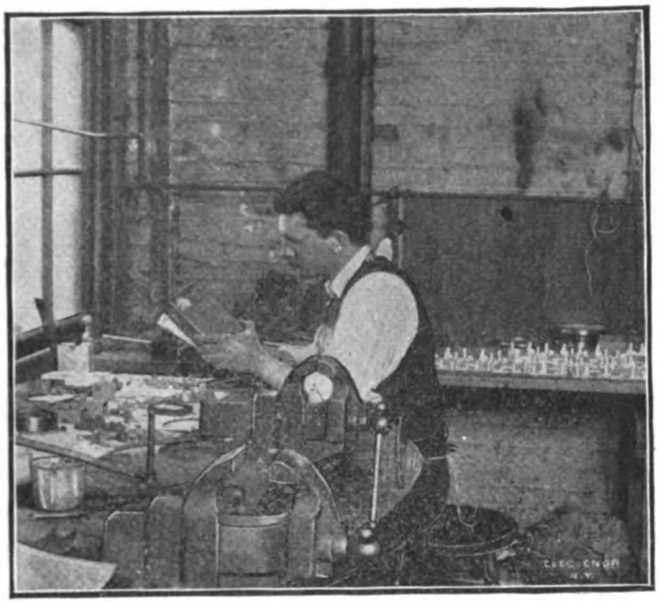

ELEC. ENGR. N.Y.

FIG. 8.—ASSEMBLING WAGNER-QUEEN VOLTMETERS.

The rear of the centre corridor just outside of the room described has been converted into a paraffining-room; the illustration, Fig. 11, shows a testing set being dipped and already well coated with paraffine. A number of pairs of pans are used to accommodate the various sized resistance sets made; one pan is supported within another with water between the pans in order to prevent the paraffine from getting too hot and decomposing—decomposed paraffine being almost a *conductor* of electricity. Just back of the office is a coat, wash and lunch room in which are hot and cold water, tables for lunching, etc.

XIII.

On the ground floor, the right hand front room is the store-room and packing-room. A series of deep, glass doored and locked closets have been built around two walls of the room, and in the closets is kept all wire not needed for immediate use, as well as all other stock supplies such as screws, galvanometer mirrors, lenses, etc. Here also are kept all the fine instruments used by the laboratory only occasionally. Work not yet issued to the hands is also stored here, as well as all extra tools, etc., kept in stock against breakage.

Back of the store-room is another work and winding room; in this room all of the winding for ammeters and voltmeters is done. For this purpose a lathe and Perret $\frac{1}{8}$ h. p. 110 volt motor are used as in the winding-room on the upper floor. A work bench and full equipment of tools, grindstones, etc., may also be found here.

Just back of this room is the battery-room. In this room are set up 60 large Julien accumulators which are connected to the switchboard in the adjoining room.

XIV.

Over on the opposite side of the house in the rear is one of the most interesting and important rooms of all. This is the Calibrating Room. In this room which is illustrated in Fig. 11, is the switchboard from which potential or current, either direct or alternating is distributed to all parts of the plant. This switchboard measures 16 feet by 9 feet. At the right of the board and about 2 feet from the floor, as will be seen, there is a shelf attached to the board.

In this shelf are held four rows of iron cups filled with mercury, while next to each row of cups is a trough filled with mercury. Two of these rows contain 60 cups per row, one row being the positive terminals of each of the 60 accumulators, the other the negative terminals. These accumulator terminals are each wired to the cups on the switchboard by No. 8 copper wire. The other two rows of cups form the terminals of resistances, 60 in number. By the use of these cups it is evident that any combination of batteries and resistances, either series or multiple can be made.

Just above this shelf of mercury cups may be seen the two copper bus bars. In all combinations whatever, these two bus bar are made the distributing centres.

In front of the switchboard and the middle of the room are seen the dynamo machines used for calibration. These machines were specially built for Messrs. Queen & Co.'s laboratory according to specifications furnished by Mr. Willyoung, by the La Roche Electric Works, of Philadelphia. There are three machines in all; a 2 h. p. motor, a small alternating machine giving 60 volts and 20 amperes and a direct current calibrating machine. The latter, Fig. 12, has combined with it a special switch and resistance box by which the two fields may be connected in series, multiple, or used singly or in any of these circumstances have extra resistance included in one or both fields. The belts used in the machines have been very carefully made, and this machine will deliver voltage from 0 by steps of $\frac{1}{10}$ volt, or even less, to 1,200 volts, giving a maximum current of a little over one-half ampere at this voltage or below it.

The bus bars are put up in sections which are connected together by heavy copper strips of the same cross section. The switches are so arranged on the board, that in case it is desired to run the calibrator, for instance, the right hand section has the storage battery connected to it in series; a switch then throws these two bus bars on to the motor circuit and the field of the calibrator in multiple; while the calibrator circuit, by another switch, is thrown on the left hand section, from which this calibrating potential is

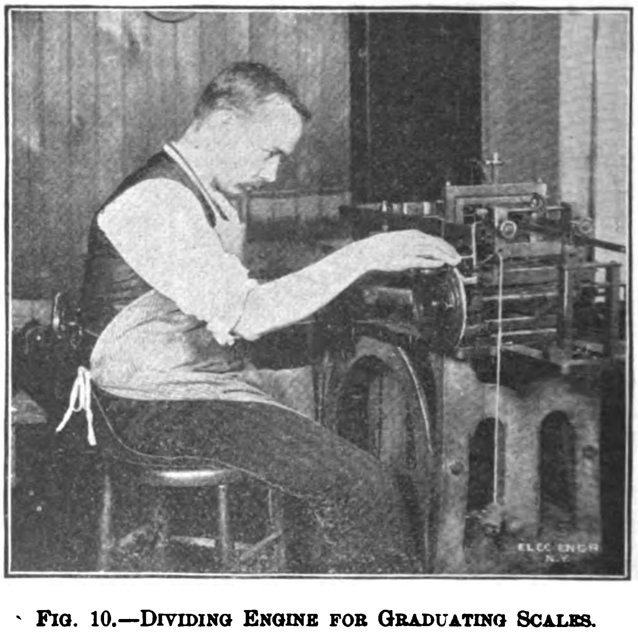

ELEC. ENGR. N.Y.

FIG. 10.—DIVIDING ENGINE FOR GRADUATING SCALES.

distributed to all parts of the premises. All the power used on the plant is secured through the medium of the storage batteries which are charged from the mains of the Haverford Electric Light Co., situated just above Ardmore.

XV.

In this room special racks have been provided for the calibration of Cardew voltmeters, many hundreds of which are sold yearly; on these racks which are illustrated in Fig. 13, twenty-five instruments may be standarized at once. A voltage of about 10 per cent. greater then the maximum working potential of the instruments is kept on for from 48 to 60 hours before the instrument is finally standarized; this is partly to "season" the working wire and partly to discover any defects which may exist in it and which might cause the instrument to break down. After this preliminary seasoning process, a scale is separately determined for each individual instrument by making a table of the readings in degrees on a special scale used for the purpose. These tables are then sent to the dividing engine and the separate dial of volts engraved. This method is greatly superior to the old one of compelling all instruments to read to the same scale, and has resulted in a great saving of labor with additional accuracy.

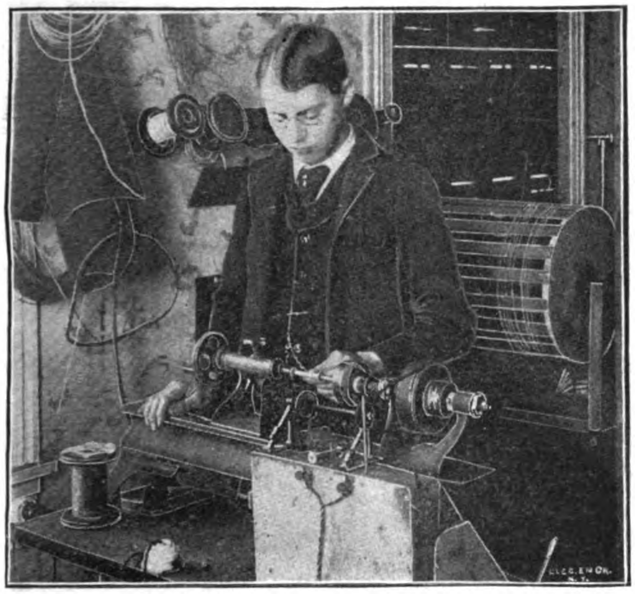


FIG. 12.—WINDING SPOOLS FOR PORTABLE TESTING AND RESISTANCE SETS.

XVI.

The Magnetic Room, an exterior and an interior view of which are given in Fig. 11, is considered to be one of the finest rooms for high grade electrical work to be found anywhere in the country, being superior to anything else of its kind except perhaps the magnetic rooms of Cornell and of the Worcester Polytechnic Institute. The room is a detached building, built of pressed brick, and 60 feet away from the nearest building, which is a small barn. The walls of this room are double and filled in with sawdust to prevent any sudden change of temperature. Not a grain of iron or other magnetic material can be found within 25 feet of the building, copper nails, etc., being used throughout. The windows and doors are also double. The window weights, catches, locks and gutter are all brass or copper, as are also the gas pipes and fixtures. The room is heated with hot water from a boiler located in the barn in the rear. The heating is done with but 2 lbs. of steam up to 65 degrees or 70 degrees F. and can be kept there within half a degree all day long, even in the coldest weather. This heating plant was put in by the Onderdonk Steam Heating and Ventilating Co., of Philadelphia.

Inside the room are five square piers each 2½ feet square, and capped with a heavy slate slab. These piers are hollow and filled in with conglomerate and extend down three feet into the ground; the floor has a clearance around them of about half an inch while weather strips make the cracks impenetrable to air currents. Three of these piers are in one straight line, being the line of the meridian, while about 40 inches opposite to the centre pier is a fourth pier at right angles to the line of the three.

On the two end piers are two standard Helmholtz-Gaugain tangent galvanometers, while on the fourth pier are a pair of telescopes and scales for observing them. One of these galvanometers can be used for measuring potentials from 0 to 1,000 volts and the other for measuring currents from 0 to 1,000 amperes. These two instruments are permanently fixed and are never disturbed. They have been carefully standardized and readings may be taken instantly to check the secondary standards used in ammeter and voltmeter calibration.

At one side of the room, on a slate slab let into the wall, is a Thomson centiampere balance, with extra resistance, and working up to 1,000 volts. This is merely intended as a check against the indications of the tangent instruments. Near to the Thomson balance is a delicate analytical balance sensitive to $\frac{1}{10}$ milligram and weighing up to 200 grams. On the wall is a standard chronometer with sweep seconds attachment and made specially for the laboratory by the Seth Thomas Clock Co.

Upon the fifth pier is placed the galvanometer used in adjusting the highest grade resistance sets. This galvanometer was specially designed for this laboratory and is said to be one of the finest instruments ever made by Messrs. Queen & Co. The instrument is of the dead beat bell magnet type and has a 1¼-inch mirror. The suspension tube is 30 inches long and the suspension a single cocoon fibre. There are three sets of coils with the instrument, of low, medium and high resistance. These coils may be quickly interchanged in conformity with changes in the character of the work. Upon the telescope table used in working with this galvanometer are permanently mounted all the keys, connections, etc., needed for quickly taking up any character of work.

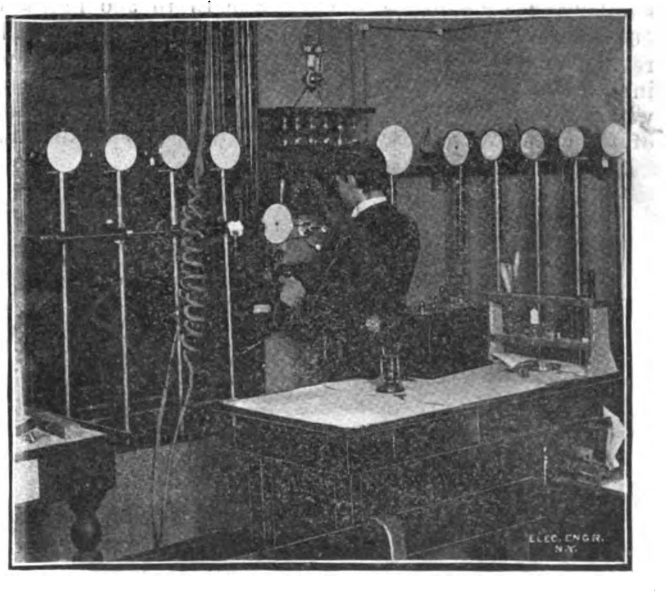


FIG. 13.—CALIBRATING CARDEW VOLTMETERS.

Just to the left of the electrician is mounted the standard set of coils used in most of the work. This set is one of the celebrated No. 1 sets, designed by Prof. Anthony, and is correct, as compared with original Cavendish standards, within $\frac{1}{100}$ of 1 per cent. Several ultimate single coil standards are also at the laboratory; these last were adjusted and were certified to by Prof. Glazebrook in charge of the Cavendish laboratory, at Cambridge, England. A table just to the right of the electrician is arranged to receive the standard slide wire bridge and apparatus used in adjusting ultimate standards. Shelves, etc., are about the room to receive work in process of adjusting.

In this room is done all the standardizing of resistance coils and boxes which require an accuracy of over $\frac{1}{4}$ per cent.; also the exact standardizing of the secondary standards used in the calibration of ammeters and voltmeters; and the adjusting of high grade shunts, determination of galvanometer constants, special tests, etc. The entire plant is amply equipped with gas and water and all conveniences.

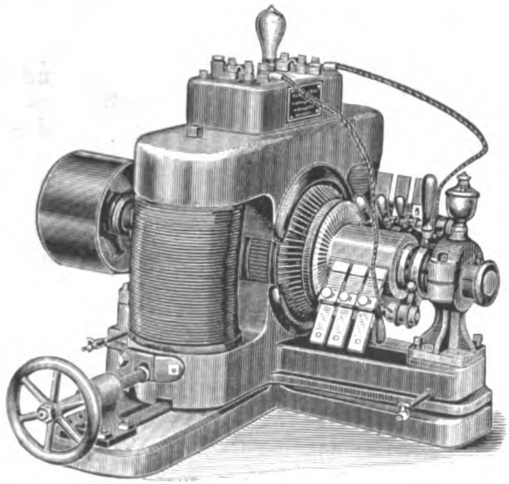
XVII.

The laboratory and its equipment were planned by Mr. E. G. Willyoung, of Messrs. Queen & Co., and have more than given satisfaction. Mr. William Young, who has been with the firm for several years, is assistant electrician and has charge of the laboratory under Mr. Willyoung. The laboratory at present employs 16 assistants, all of them having had special training in practical and theoretical electricity. One of these assistants is a graduate of the University of Pennsylvania; one of Amhurst and Cornell; one of the Philadelphia High School; two of other schools, and eleven of the Philadelphia Manual Training School. It is interesting to note how largely the Manual Training School graduates are employed by Messrs. Queen & Co.; indeed, it has been said in jest that this School is run for their benefit and that they take the entire output as soon as the youths are graduated.

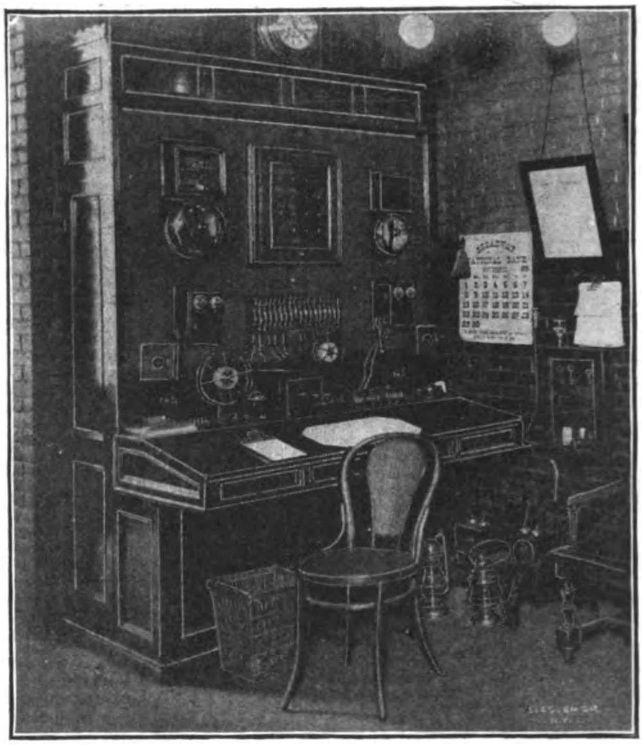
In conclusion the writer desires to acknowledge his indebtedness to Mr. E. G. Willyoung for the many courtesies extended and information volunteered during a recent visit to Messrs. Queen & Co.'s various establishments.

THE INCANDESCENT GENERATOR OF THE DUPLEX ELECTRIC CO.

The generator illustrated here has a capacity of 6 h. p., and is made by the Duplex Electric Co. Ltd., of Corry. Pa. The incandescent machines made by this company are very similar to their motors and vary from 15 to 500 lights of 16 c. p. They sit on a sliding base with belt-tightener. The regulation is accomplished automatically. They are simple in construction, self-regulating, thoroughly automatic, without the use of wasteful rheostats or appliances outside of the generator. They run quietly without sparking and without any change in the position of the brushes under any possible change of load and have a very low temperature at full load. The armature used in this generator is a modification of the Gramme. Its core is a drum, built on a brass spider of the best charcoal wire wound on an iron frame having a cross-section, which divides the core into four parts. The armature is carefully balanced both before and after winding. The air space is reduced to a minimum, bringing the field magnets, the cores of which are of best wrought iron, close to the armature and forming a highly efficient magnetic field. The commutator segments are of tempered copper, insulated by mica and firmly held in place by a fibre collar which renders it impossible for them to fly out. The brushes are composed of thin copper strips fastened together at one end. They do not require shifting and are free from sparking under extreme variation of load, thus ensuring their long life. The brush holders are simple in construction, of brass and thoroughly insulated. The bearings are made of the best anti-friction metal, while the boxes are attached to the pedestals by means of a ball-and-socket joint which secures perfect alignment.



THE DUPLEX INCANDESCENT GENERATOR.



INSPECTOR'S SWITCHBOARD, EDISON STATION, BOSTON.

A CENTRAL STATION INSPECTOR'S SWITCHBOARD.

BY

B. B. Hatch

THE inspector's switchboard in the Boston Edison station contains scarcely anything new or unusual to the electrical fraternity, but as it has attracted considerable attention from central station men who have visited us, a description of it seems in order, so that other stations may be benefited by the same, if it should contain any features new or worthy of consideration.

The Edison Illuminating Co., of Boston, maintains a corps of inspectors whose duty it is to care for all complaints, make small repairs and look out for the welfare of their customers generally, both day and night. It is in their room on the fourth floor of the Head Place station that the board is located. The board is built of oak and combines both a switchboard and desk, the upright portion consisting of a polished slate front. On this are mounted the fire-alarms, telephones and annunciators. On the desk are placed a watchman's register and automatic telegraph apparatus communicating with the various hotels and theatres so that they may call an inspector without delay. In the base of the board are located the batteries and cable terminals of the bell system for the entire station.

The board presents a very neat and compact appearance, and has received much favorable mention from central station people who have seen it. It was built in the company's shops and was designed by the writer, their chief inspector.

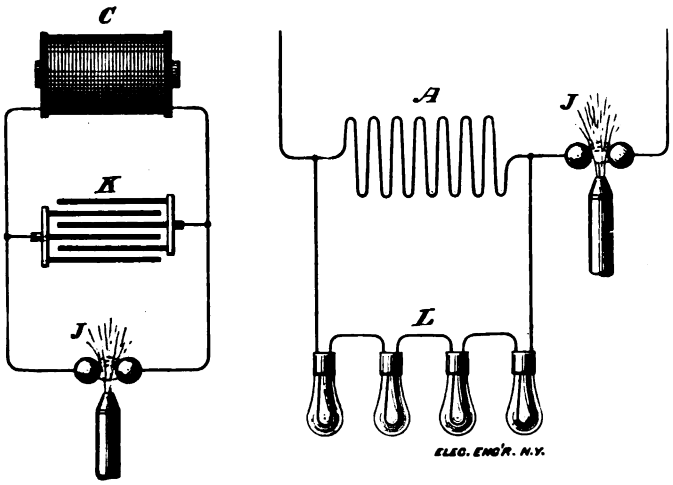
FURTHER EXPERIMENTS WITH CONDENSER, SPARK AND AIR JET.

BY

Elihu Thomson

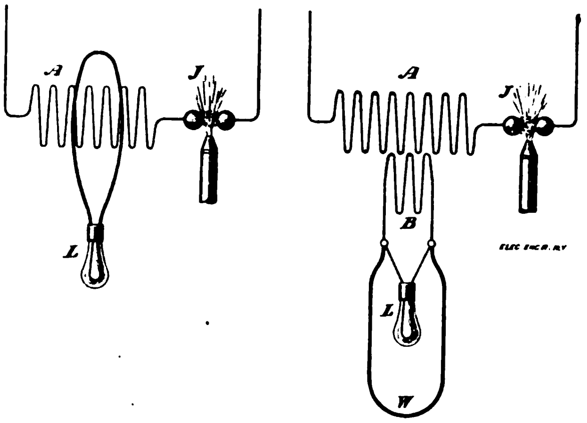
In a prior communication[1] I described some effects which were obtained by the induction of Leyden jar or condenser discharges passing through coils or helices upon other coils or helices placed in inductive relation with the former, and the effects of the use of an air jet or blast upon the spark discharge of a condenser as acting to enhance the inductive effects of the discharge were alluded to. It is my purpose in the present paper to still further emphasize the novel actions brought about by allowing a stream of air to play upon the discharge obtained from a condenser connected to the terminals of a high potential coil, such as a secondary whose primary is fed by alternating currents of any frequency.

Fig. 1 typifies this arrangement. C represents a coil which may give from 10,000 to 20,000 volts as a secondary to a suitable primary fed with alternating currents of suitable voltage. The terminals of this coil are connected to the condenser K, as indicated, and the discharge of this condenser is effected by means of terminals at J, and an air jet is allowed to play upon the discharge at J for the purpose of making use of discharges of very high frequency. In other words, the inductive effects of the discharge passing across the gap J, which without the presence of the air jet would be quite feeble, may be enormously enhanced, and represent in fact the passage of currents of extraordinary frequency.



FIGS. 1 AND 2.

Thus, in Fig. 2, if a coil A of a few turns of heavy copper wire, even as large as a quarter of an inch in diameter and, say, 15 to 20 turns, wound to a diameter of about 6 inches, be interposed in the path of the discharge, or in series with the discharge terminals at J, the self-inductive effects of this coil are such that a number of incandescent lamps in series are lighted in shunt to it; without the air jet at J the lamps do not incandesce. This experiment shows the presence of enormous self-induction in A as its actual resistance can be but a very small fraction of an ohm. The presence of such high self-inductive actions in A naturally suggests that it may be used as a primary and produce strong inductions in a parallel circuit. Thus, in Fig. 3, if a single turn be taken around the coil A and an incandescent lamp L, demanding 25 volts and two amperes of current, be connected across the terminals of the single turn, as shown, the lamp at L is lighted by the inductive effects, but this does not occur without the air jet at J.



FIGS. 3 AND 4.

Another demonstration of the extremely high frequency of the discharges is indicated in Fig 4, where two or three turns of conductor are placed in inductive relation to the coil A, such as are indicated at B. In the figure they are indicated as being separated, but it is to be assumed that they are wrapped around the coil A and perfectly insulated therefrom. Several turns in B are sufficient to illuminate the lamp at L, depending upon its voltage and its resistance, even though its terminals are solidly shunted by a heavy copper wire W several feet in length. This experiment is somewhat similar to one of Mr. Tesla's experiments in that it depends upon the enormous frequency of the discharges in B. The effects are practically *nil* without the air jet playing at J.

If, as in Fig. 5, the coils A and B be employed as a simple induction coil without an iron core, it is found that at a distance of a quarter of an inch, at J, with the air jet passing at J, very heavy, thick sparks pass at D, which space may be made three-quarters of an inch in length, the sparks resembling Leyden jar discharges, although the number of turns in B is only 20 and in A about 10. Both coils are constructed of very heavy copper wire and the turns kept apart, the average diameter of the coils being six inches.

In Fig. 6 is shown a modification in which the outer coil, consisting of about 20 turns of copper wire about a quarter of an inch in diameter, and the inner coil about 12 turns of somewhat similar gauge, are connected together so as to form, as it were, a closed circuit with each other through the lamps at L. The discharges are sent through the system as before by the air jet spark at J from the condenser K fed by high potential alternating currents of 10,000 to 20,000 volts. The lamps at L are brilliantly lighted in this experiment. Variations of the effective length of the single coil A, which is made of bare wire, can be obtained by a sliding contact, as indicated in the figure. This contact may be made to include more or less of the turns of A.

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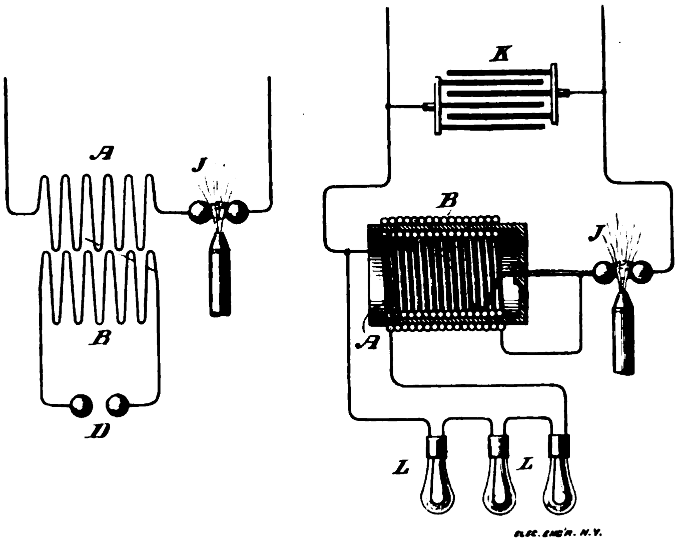
[1] THE ELECTRICAL ENGINEER, Feb. 17, 1892.

A modification of the experiment Fig. 6 is shown in Fig. 7 in which two coils A and B are connected in multiple, but the coil A is connected through the lamps, which are brought to high brilliancy on the passage of the discharges at J with the air jet playing thereon. The coil B has the greater number of turns in this experiment and probably feeds its lamps through the coil A by a sort of local current flowing through the two coils in series, though this is very difficult to determine. If on the passage of the discharges across J there are unequal inductions in the coils A and B, which set up currents local to the lamps, we would have an action analogous to the flow of currents locally to the coils connected in multiple arc when they are in unequal positions with respect to a changing magnetic field, causing an inequality of electromotive forces to exist.

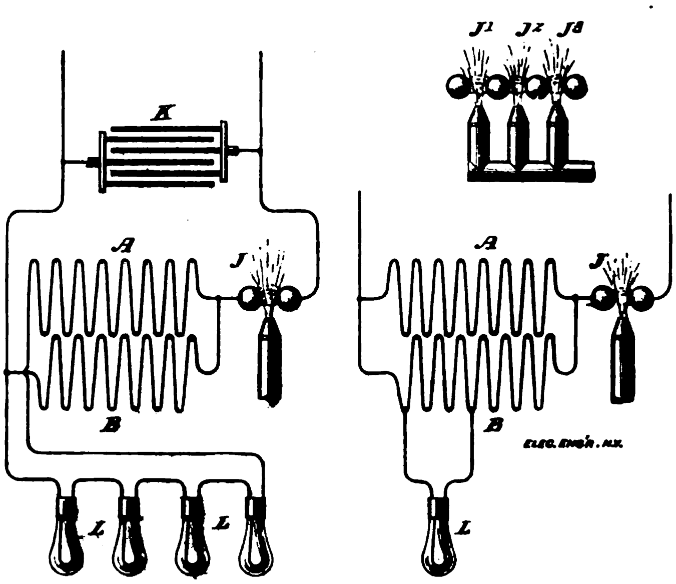
Fig. 8 shows that with the coils connected in multiple, even though their turns be unequal, it is easy to light a lamp L which spans a few of the turns in the outer coil. The lamp used in this case was a 100 volt lamp. The vigor of the self-inductive actions is certainly remarkable, and with the ordinary periodicities of alternating current, namely, 125 or 250 alternations per second initially used, effects due to very high frequencies are very readily obtained. The actions appear to be more vigorous the larger the condensing surface in K, the longer the spark at J, and the more vigorous the air jet used. The air jet hitherto employed by me has been of very moderate pressure and I expect to increase its force with the construction of a much larger apparatus for getting these inductive effects.

It would appear that we have in the air jet and the spark discharge a partial solution of the problem of obtaining very high frequencies in a fairly continuous manner. Fig. 9 shows an arrangement which may be found more effective when working with very powerful apparatus; that is, a series of spark gaps J^1, J^2, J^3, are each of them provided with air jets blowing therethrough. A much higher potential will be required to leap these combined spark gaps while the extinguishing action or the blowing action of the jets will be equally vigorous in each space. The apparatus is so simple and of so little cost to construct even for obtaining, by inductive actions of this character, sparks of great length and extremely high voltage, that it is contemplated to construct a much larger apparatus than that which has hithorto been used.



Figs. 5 and 6.

The coil B in these experiments while made of a few turns of heavy, coarse wire, was in my former communication described as constructed of a much larger number of turns of fine wire immersed in oil, and it was shown that torrents of long sparks could readily be obtained therefrom. The ratio of inductions between the coils A and B seems to be approximately those in an ordinary transformer, and while it is very difficult to estimate from the length of spark alone the actual voltage existing, yet it is certainly true that very many thousands of volts potential difference exist between the terminals during the passage of such sparks as 7 inches and 8 inches in length. The striking distance, however, appears to increase much more rapidly than the potential, and if the law holds good it would appear to be easy to secure sparks of very great length by extending the scale of my experiments.



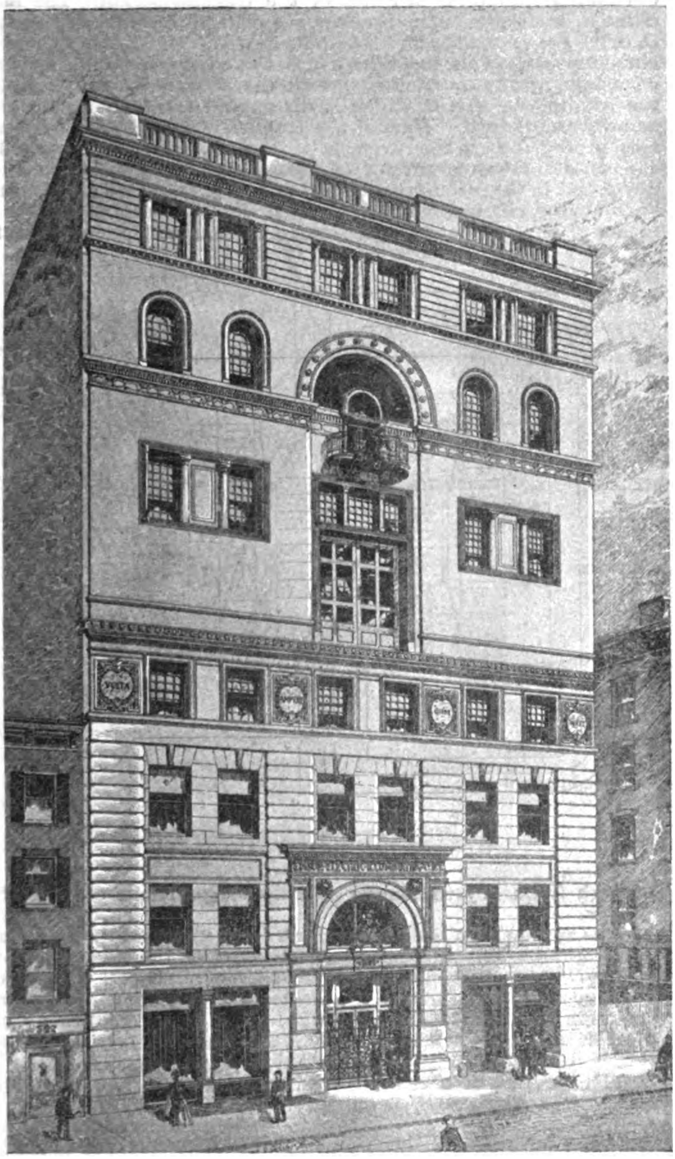
Figs. 7, 8 and 9.

It may be remarked here that in reference to striking distance, it is a question whether there is not a certain potential which from a certain sized terminal will strike at any distance. It would appear that in order to prevent the discharge from passing into the air either in the form of a brush or a discharge connecting the terminals, the terminals themselves should be made in the form of larger and larger poles kept perfectly smooth the higher the potential worked with, and that for voltages as high as 200,000 or 300,000, terminals tipped with small balls would act practically as points and allow discharge into the air in the form of a brush discharge, if this potential could not actually cause a leap between the terminals.

THE NEW STATION OF THE EDISON ELECTRIC ILLUMINATING COMPANY, NEW YORK.

The credit of having installed the first central station in the world for the distribution of current for incandescent lighting is, as our readers are aware, due to the Edison Electric Illuminating Company, of New York City. Started in 1882, this station has been in continuous operation ever since, and the success early obtained in its working soon induced the company to erect other stations, with a result that during the past few years stations at Twenty-sixth street and Thirty-ninth street, New York, have come into operation. The old station in Pearl street, however, has long since ceased to meet the demand made upon it, so that the company some time ago resolved to erect a central station which should be able to meet fully all requirements, both as regards capacity and economy of operation.

The new station which is situated at the corner of Pearl and Elm streets, may be said to be growing gradually, the plant at present installed being merely temporary in its nature. Thus, during the past year the company have been developing the most economical type of engine to employ, and believe that they have secured this in the Van Vleck disconnective engine, described in our issue of January 20, and now in daily operation in their Twenty-sixth street station. They are now constructing under the supervision of their engineer, Mr. John Van Vleck, a similar type of engine, intended to work up to 1,600 h. p., which is to form one of the set of small units for the new station. As the load on the station increases, larger units will be required, and provision is being made for six or eight of these of from 4,000 to 5,000 h. p. each. Thus it will be seen, while affording an ample number of large units, the error will not be made of placing the station in such a position that a break down in any one member would seriously affect its working.



New Edison Station, Elm St., New York City.

When fully equipped to carry 200 pounds steam pressure and over, quadruple expansion engines will be employed. Owing to the peculiar day load which obtains in this district and which reaches a maximum between 10 and 11 o'clock a. m., it will admit of almost 12 hours' operation at full capacity, and hence this high load factor will permit of the economical employment of quadruple expansion engines.

The contemplation of quadruple expansion naturally necessitates the employment of high steam pressures, and in the matter of boilers the company are not yet quite decided as to the type they will employ, as they are of the opinion that better results can be obtained in the matter of evaporative power than can be obtained with the present type of water-tube boilers. Their object is to get a safety boiler with an evaporative capacity equal to that of a first-class marine boiler; the latter type, of course, cannot be used on the score of safety.

The steam piping also is receiving its due measure of attention and is designed throughout to withstand 300 pounds pressure. Mr. Van Vleck has devoted considerable study to the construction of the steam piping which will be on what is known as his "Cannon" System. This is a multiple pipe system, consisting of a number of pipes 8 or 9 inches in diameter placed in a row and expanded into headers with flanges. These flanges will probably be 4 inches thick and bolted with 2½ inch bolts. No duplicate or cross-over piping will be used as it is believed that the method of construction here adopted will make all repairs unnecessary and avoid all the trouble usually encountered with high pressure steam piping.

It is contemplated to operate the boiler furnaces under hot blast, and for this purpose, the engine and boiler-room will have closed doors, these rooms being slightly under pressure, and supplied with fresh air forced in through ducts below the floor. This air, on rising, accumulates all the radiant heat from the engine, piping, boilers, etc., and in the hot rooms above will attain a temperature of 100 to 150 degrees. From these hot rooms, again the air will be exhausted and sent through heaters in the stack, where it will be further heated up to 300 to 350 degrees. From these heaters it will find its way to the ash-pit of the boilers, the whole forming what is now called the hot-blast system, which has been very successfully applied on many English steamers and is now being introduced on American vessels.

With the arrangement as here outlined, energy can only find its way out of the station through three channels; first, in the form of electrical energy, conveyed through the conductors; second, as heat contained in the heated air escaping through the stack, and which has been reduced to as low a limit as possible by the feed-water heaters and hot-blast heaters; and third, as heat contained in the water flowing from the condensers which will also be reduced to the lowest practical limit by heating the feed water and by the employment of quadruple expansion engines.

In the matter of the electric generators to be employed, the company has also gone to work very deliberately, and favors a series-wound disc dynamo, and the indications are that such a type of machine will be used.

The system of electrical apparatus within the station will also be of an exceedingly novel character. Among other things, the output in amperes on each feeder will be so indicated as to automatically form a curve on the side wall, showing the distribution of the load on the entire system. The pointers of the ampere-meters will all terminate in black dots, which will move vertically up and down through slots. The pressure at the ends of the feeders will also be shown in a similar manner and will form a straight line when the pressure is normal all over the system. Any abnormal pressure will thus evidently be indicated by a break in the straight line, and will thus immediately attract attention. The main voltmeters to be employed will be constructed on the principle embodied in Sir William Thomson's engine-room voltmeter specially adapted for the present purposes by Mr. Van Vleck. These voltmeters will be two feet in diameter and are now being constructed by James White, of Glasgow.

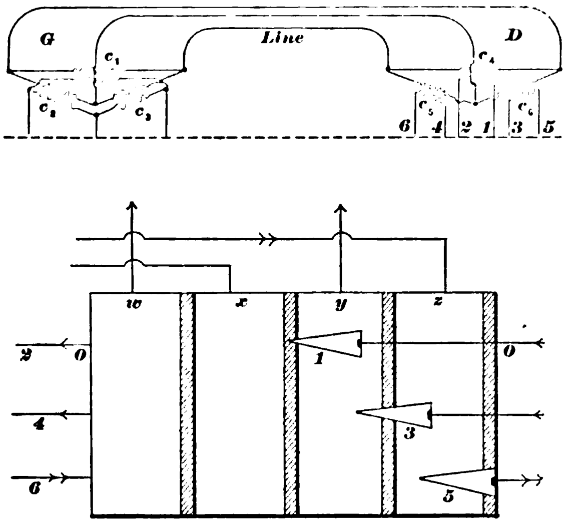
The station being designed for 500,000 lights, the main ampere-meter will be constructed to measure 200,000 amperes. It is also proposed to use Sir William Thomson's electrostatic voltmeters on the common pressure wires. These voltmeters, as is well known, require no actual current for their operation, and hence they will not deflect the comparative indicators, and will thus make it unnecessary to run the common pressure wires to the ends of the standard feeder.

It will, of course, require some time to put all these ideas into actual practice, but the work is steadily going on and will be pushed with all possible speed. It must be considered a subject for congratulation that so large and important a company as the Edison Electric Illuminating Co., of New York, is under the management of one so intelligent and far-seeing as Mr. R. R. Bowker, the first vice-president of the company, who has done much to place the company in its present splendid condition.

A PROPOSED SYSTEM OF ALTERNATING DIRECT CURRENT TRANSFORMATION.[1]

BY F. JARVIS PATTEN.

THE lecturer described several devices affording the means of transforming a single alternating current of short wave length or high frequency into triphased alternating currents of long wave length or low frequency, and also a means of transforming a single alternating current into a continuous direct current of uniform E. M. F. The requirements of practice would probably be met by two independent armature windings carried on the same core. One winding has a collector directly and reversely connected, and is supplied with a single alternating current. This winding is also connected to the other one at three equidistant points, and the other winding is provided with an ordinary Gramme collector, and, if desired, three rings that are connected to three intermediate equidistant points of this winding.



FIGS. 1 AND 3.

This reduces the machine to a single armature with two windings and two collectors, or at least to two separate armatures and collectors, which form will doubtless be found preferable. The consumption circuit will be connected either to the brushes bearing on the collector or the rings of the secondary winding, according to which function of the machine it is desired to render operative.

Thus a single alternating current of ordinary period may be transformed either to triphased alternating currents of low period or to a direct current of comparatively uniform E. M. F.

If a three-wire system, like that shown in Fig. 1, is used throughout, giving triphased currents at the delivery end *D*, from the secondaries of the three converters, the transformation of these triphased currents to a single direct current of uniform E. M. F. or to triphased currents of a much lower frequency of alternation, can be accomplished on similar lines. It is well known that multiphase motors give better results with currents of comparatively low frequency, 40 to 80 per second being the reported practice abroad. On the other hand, the converters for reducing potential increase rapidly in size as the frequency of alternation decreases; consequently very large converters are required for such systems. These features are antagonistic and render the conversion apparatus costly if low frequencies are essential to the proper working of rotary field machines.

The system shown in Fig. 2 admits of using high frequencies on the line and in the conversion apparatus at *G* and *D*, for raising and lowering potential, while the transformer, Fig. 14, changes these triphased currents of high frequency either to a uniform direct current or to triphased currents of a lower rate of alternation.

At the delivery end *D*, Fig. 1, separate converters c_4, c_5, c_6, (not interlinked) are used, the secondaries having free terminals, as shown, which are taken to the brushes 1, 3, 5 and 2, 4, 6, bearing on the commutator of the ring R_2, Fig. 2, the winding of which is connected at three equidistant points *x*, *v*, *y* of the ordinary Gramme ring and collector R_3, or to three ring contacts, as may be desired, according to whether a direct current or triphased currents required, as a result of the transformation. The machine R_1 is simply a synchronizer, requiring only sufficient power to drive the apparatus and is supplied with one of the triphased currents only. This machine keeps the whole apparatus in synchronism, and the currents from all the secondaries are taken to the winding R_2, Fig. 2, which is direct and reversely connected as before explained. Thus, if the frequency throughout the system in Fig. 1 were 288 reversals per second, and there be, say, 12 segments in the commutator of the ring R_2, there would then be developed in the circuits connected to *x*, *v*, *y*, triphased alternating currents having 48 reversals per second. We have, then, here a means of changing at a single transformation multiphase currents of high frequency to similar multiphase currents of low frequency.

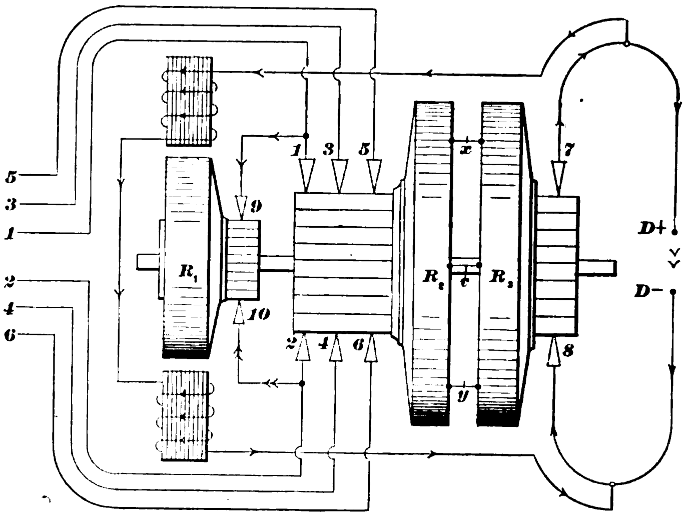


FIG. 2.

This system admits of using high frequencies on the line, and in the conversion apparatus at both ends of the line, and low frequency in rotary motors at the delivery end. If, instead of being connected to three rings, the leads *x*, *v*, *y* are connected, as shown in the figure, to another winding, a direct current of uniform E. M. F. will flow in the circuit *D*+ *D* —. This transformation requires no further explanation here. Fig. 3 shows a developed view of a part of the commutator of the ring R_2 and the relative positions of the brushes.

To prevent short circuiting, the segments are separated, as shown, so that a brush will not bear simultaneously on adjacent segments, and for obvious reasons, the brushes have a lag behind each other of one-third of a segment. The arrows show how the currents are flowing at the time being. Brush 1 has no current; brush 3 has a positive, and brush 5 a negative impulse.

If these transformations can be made on a large scale economically, it will be possible to supply not only alternating current apparatus of every description, including multiphase devices, but direct current apparatus as well, from a single high tension alternating current. When the original source of supply is a water power, and the distance is not too great the losses of conversion may well be brought within commercial limits.

MR. GILBERT WILKES, engineer for the Eastern District of the Edison General Electric Co., has resigned that position and has become the chief engineer of the Detroit Electrical Works, to take charge of their electrical work. Mr. Wilkes will enter upon his new duties March 1.

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[1] Abstract of a paper read before the American Institute of Electrical Engineers.

Society and Club Notes.

A TRIBUTE TO THE MEMORY OF GEORGE WORTHINGTON.

AT a meeting of the members of the Electric Club held at the club house Friday evening, February 12th, the following minute was ordered to be spread upon the records of the club:

> The Electric Club of New York hereby expresses the profound sorrow felt by its members upon learning of the death of Mr. George Worthington.
>
> His genial companionship, his hearty good will, never failing towards any, his disinterested friendship, his utter unselfishness, endeared him to all who came within the circle of his acquaintance. The memory of these traits of his, as well as of his manly independence and courage, leaves in our minds and hearts the gracious sense of past comradeship to temper the sad knowledge of our friend's departure.
>
> He was one of the founders of this club, and the leading spirit in the work of building it up to usefulness and for the benefit and pleasure of its members.
>
> The secretary is requested to communicate this minute to the family of Mr. Worthington.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the council meeting, Feb. 16th, the following applications for associate membership were made:

Fred Deland, Western manager, *The Electrical World*, 465 The Rookery, Chicago, Ill.
Elisha Gray, Highland Park, Ill.
Adolf Graner, electrical patent agent, 529 North 35th St., Philadelphia, Pa.
John N. James, electrician, Naval Observatory, Washington, D. C.
A. F. McKissick, professor of electrical engineering, the A. & M. College of Ala., Auburn, Ala.
Lee L. Summers, assistant electrician, Western Union Telegraph Co., 18 W. U. Telegraph Bldg., Chicago, Ill.

The following applications for transfer from associate to full membership, approved by the board of examiners, January 12th, were acted upon:

Charles B. Burleigh, electrician, Thomson-Houston Electric Co., 620 Atlantic Ave., Boston, Mass.
Robert Edward Dunston, president, the Connecticut Motor Co., Plantsville, Conn.
Angus S. Hibbard, general superintendent, American Telephone and Telegraph Co., 18 Cortlandt St., New York City.
Charles H. Wilson, general superintendent, Chicago Telephone Co., 203 Washington St., Chicago, Ill.
Park Benjamin, electrical expert and engineer, 32 Park Place, New York City.

The American Institute of Electrical Engineers has decided to hold its annual meeting this year in Chicago.

LOUISVILLE ELECTRIC CLUB.

THE representative members of the different electrical firms in Louisville met in the parlors of the San Carlos Hotel on February 1, for the purpose of organizing an electrical club. Mr. Sidney J. Sproul, superintendent of the Louisville Electric Light Company, was elected temporary president, and Mr. D. W. Sea, of the Edison General Electric Company, was made temporary secretary.

College Notes.

UNIVERSITY OF NEBRASKA.

THE new Electrical Engineering Laboratory is nearly completed. It is 50 x 60 feet, with high roof for good ventilation, and is designed especially with regard to plenty of light.

In this building are being placed two engines, one 100 h. p. tandem compound condensing Gidding's automatic, made by the Sioux City Engine Works, and one 25 h. p. Atlas automatic, made by the Atlas Engine Works, Indianapolis, Ind. Each engine may be coupled to either end of a line of counter-shafting through the centre of building or belted direct to dynamos. The line of counter-shafting is made by the Falls Rivet and Machine Co., Cuyahoga Falls, Ohio, and is a model of accurate workmanship. The driven pulley from the 100 h. p. engine is attached to the shaft through a Van Winkle 100 h. p. spring dynamometer and thus allows accurate power measurements to be made at all times. Only clutch pulleys are used, so that any dynamo may be started or stopped at pleasure without stopping the engines or throwing off belts. By a system of friction clutch couplings the whole line of shafting may be driven from either engine independently, or from both engines working together as occasion may require. To this line of counter-shafting are connected one Westinghouse 500-light 1,000 volt alternator, one 25-light 2,000 c. p. Thomson-Houston arc dynamo, one 25-light 2,000 c. p. Wood arc dynamo by the Fort Wayne Elec. Company, two 15 K. W. Edison dynamos arranged for the three-wire system, and one 100-light 100 volt Weston dynamo, thus representing nearly every type of machine used at the present time and of commercial sizes. The engines are arranged so that they may be run at high pressure, exhausting through improved exhaust heads into the atmosphere, or they may be connected with a 100 h. p. Worthington independent jet condenser and run as condensing engines. Steam is furnished by a 125 h. p. Sterling boiler placed in a separate building in the rear. Besides the Van Winkle dynamometer, a Prony friction brake, a Brackett cradle dynamometer and two dynamometers of special design, one an oil and the other a magnetic dynamometer, are provided for power measurements. Each electric system represented is complete in every detail. Four handsome fireproof switchboards are provided on which are placed the measuring instruments and regulating devices of each system. About $5,000 has been expended in importing standard electrical instruments alone, and a large amount of apparatus, such as current meters, watt meters, lamps, transformers, etc., possessing special features, have been procured from other firms than those named. Sixty-five storage cells of three different types are used to light the building and for experimental work.

The total addition to the equipment in this department this year will amount to over $30,000, which thus will make the department more completely equipped for its work than any other in the West, and equal to any in the whole country. An outline of the course will be given later.

Legal Notes.

ELECTRIC RAILWAY INFRINGEMENT SUIT—WESTINGHOUSE PATENTS.

THE Westinghouse Electric & Manufacturing Company has recently begun an important suit against the Pittsburgh & Birmingham Traction Company for the infringement of its patent No. 442,459 covering a device which has rendered the electric street railway motors both noiseless and durable. When the Westinghouse company began the manufacture of its motors they were confronted by the objection raised by numerous users of electric motors to the noise of those with which they had experienced. The engineers of the company considered the subject very carefully and there was worked out in due time a device for enclosing the gears in such manner as to suppress the noise and at the same time to provide automatically for a proper lubrication of the teeth of the gear wheels.

The company has put out several hundred motors with these gear cases, and they have been successful in their operation from the very start, and have fully demonstrated the fact that street railway motors can be run without noise, with the further advantage that the wear and tear and consequent expense of maintaining them can be reduced to a nominal figure. The successful running of the motor furnished by the Westinghouse Company, has, it is claimed, made this form of device so desirable that nearly all of the other companies engaged in the business have taken the risk of infringing the patent by closely copying the plans of the Westinghouse Company.

The present suit has been brought as a test case.

THE GREEN ELECTRIC RAILWAY PATENTS.

IT is stated that suits will be brought to enforce the rather extraordinary patents on electric railroading methods granted not long since to C. Green, of Kalamazoo, and noted in these pages. Mayor O. S. Kelley, of Springfield, Ill., is said to have a large amount of money he wishes to lose in trying to "demand royalties from every electric railroad using the overhead system."

Reports of Companies.

ELECTRICAL CONSOLIDATION AT ST. JOHN, N. B.

A CONSOLIDATION of the electrical interests in the city of St. John, New Brunswick, has been effected by the organization of a new company known as the Consolidated Electric Co., Limited; this company have taken over the Eastern Electric Co., Limited, the New Brunswick Electric Co., Limited, and the St. John City Railway Co., and it becomes one of the largest companies in Canada. The new company will have a capacity of 6,000 incandescent lights and 300 arcs. They have the contract for the lighting of the city, and anticipate a large increase in both lighting and motor business.

The officers of the company are: John F. Zebley, of New York, president; H. B. Zebley, of New York, secretary-treasurer; Chas. D. Jones, of St. John, manager, backed by a strong board of directors composed of New York and St. John gentlemen.

Letters to the Editor.

THE PERRET MULTIPOLAR FIELD,

In regard to Mr. Perret's reply to my criticism in The Electrical Engineer of Jan. 20, I will say but little, as he seems inclined to beg the question entirely, and I can see no advantage to be derived from a continuation of the controversy. What Mr. Perret *meant* in his original article no one should know better than himself, and I have no desire to enter into an argument as to the advantage of laminated fields.

In order, however, to justify myself before those who have done us the honor to follow us, I will quote from Mr. Perret's original article of Nov. 1890 (which statement also appears in The Electrical Engineer of Jan. 6), as follows:

"Now, if we so dispose the magnetic circuit as to cause the lines of force to enter the armature core at one point, to leave it at another, to *enter it again at a third point and to leave at a fourth*, it is obvious that the conductor will cut all the lines at four points in each revolution, and that it will therefore generate the same E. M. F. at one-half the original speed." "If we increase the number of poles to six, we shall obtain the same effect at one-third the speed, etc," * * "*This, then*," viz., causing the flux to enter and leave at successive points on the armature, "*is the principle of construction by which we secure low speed.*" (The last italics are my own.)

As Mr. Perret admits that "in practice all the lines of force do not enter and leave the armature at the consecutive field poles," and that it would be of no advantage if they did, I can see no need of further comment.

H. R. Wellman.

Cleveland, O.

FORMING AN ELECTRICAL CLUB AT ERIE, PA.

About fifty young men of our city, most of them engaged in our electrical manufacturing establishments, have organized as "The Erie Electrical Club," for the purpose of studying the principles and phenomena of electricity. We have engaged Prof. J. Brownell Rogers, of the High School faculty, to deliver a course of 12 lectures on electricity. We meet each Thursday evening in Prof. Rogers' laboratory at the High School where we have all the advantages of apparatus and the use of the Edison incandescent circuit for experiment.

Member.

Erie, Pa., Feb. 13, 1892.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEBRUARY 9, 1892.

Alarms and Signals:—

Repeater for Electric Circuits, M. G. Crane and F. W. Cole, 468,473. Filed July 2, 1889.

A repeater for use in connection with fire alarm signals and the like.

Resetting Device for Annunciators, R. A. Schoenberg, 468,697. Filed July 31, 1891.

A pneumatic reset for electric annunciators (see The Electrical Engineer, Feb. 10).

Conductors, Conduits and Insulators:—

Elevated Electric Conduit, C. O. Newton, 468,388. Filed Dec. 18, 1889.

An elevated support or conduit for a large number of wires or cables, capable of ready access but secure against unauthorized interference.

Electric Cable, W. Vogler, 468,585. Filed March 7, 1891.

A cable having an insulated central core and a return circuit consisting of several surrounding wires held in position by a series of fibrous threads.

Insulating Coupling, L. McCarthy, 468,772. Filed Oct. 19, 1891.

An insulated pipe joint.

Insulating Coupling, L. McCarthy, 468,773. Filed Oct. 19, 1891.

Similar to No. 468,772.

Distribution:—

Electric Lighting System, S. L. Trippe, 468,487. Filed Feb. 25, 1891.

Claim 1 follows:

The combination, with an electric generator and a series of two or more circuits, of a switch and transformer and an electromagnet both interposed between the generator and the circuits.

System for Operating Glow Lamps by Means of Multiphase Currents, J. F. H. Görges, 468,500. Filed Sept. 3, 1891.

Consists of a number of rotation current conductors corresponding to the number of phases of the current, and a number of current introducers to each lamp equal to the number of said conductors.

Electric Governor, J. T. O'Brien, 468,686. Filed Feb. 9, 1891.

Consists in the combination of a curved solenoid and armature, a series of contacts, a circuit closer and opener operated by the said armature, a series of resistance coils and electromagnetic cut-outs.

Dynamos and Motors:—

Dynamo-Electric Machine, G. E. Dorman, 468,416. Filed Dec. 17, 1890.

Relates to improved method of connecting commutator strips.

Ring Armature, J. G. Pool, 468,690. Filed Sept. 7, 1891.

An improved form of closed circuit ring armature for multipolar dynamos and motors.

Electric Motor, J. T. Wilson, 468,716. Filed Aug. 6, 1891.

An electric motor in which continuous rotary motion is converted into effective reciprocating motion.

Heating:—

Electrically Heated Smoothing Cylinder, W. Mitchell, 468,426. Filed May 26, 1891.

An electric ironing apparatus.

Lamps and Appurtenances:—

Carbon Holder for Arc Lamps, S. P. Parmly, 468,411. Filed Sept. 30, 1890.

A double carbon holder provided with a swivel joint and a clamp for simultaneously grasping both carbons.

Arc Light Globe Holder, C. A. Pfluger, 468,412. Filed Apr. 6, 1891.

A combined globe holder and dust guard for arc lamps.

Arc Light Hanger for Inside Use, C. A. Pfluger, 468,413. Filed May 15, 1891.

An arrangement for conveniently raising and lowering an arc lamp.

Electric Arc Lamp, A. G. Waterhouse, 468,711. Filed Aug. 21, 1891.

Consists of a novel arrangement of the automatic cut-out devices for arc lamps.

Miscellaneous:—

Magnetic Toy, G. A. Goodson, 468,338. Filed Apr. 6, 1891.

Electric Alarm Clock, W. S. Burroughs, 468,414. Filed Mar. 25, 1890.

Magneto-Electric Machine, J. Hunt, 468,451. Filed Apr. 24, 1891.

Relates to improved means of generating a single impulse of electric energy and sending it over a circuit, for use in blasting, etc.

Lightning Arrester, E. Thomson, 468,497. Filed May 5, 1890.

Consists of a series of conducting particles supported in a form of plastic insulating material and arranged so as to form a succession of small disruptive spaces in the path of the discharge.

Electrical Indicator, M. A. Deuel, 468,597. Filed July 3, 1890.

A magnetic indicator for showing the condition of telegraph lines.

Magnetic Separator, E. Ferraris, 468,599. Filed Mar. 13, 1891.

Consists of a wheel carrying a number of electromagnets on its periphery connected with one another and with a commutator at right angles to the axis of the wheel, and a rim of magnetic metal on which the ore is carried and separated by the change of current.

Electric Connector, G. Gibbs, 468,654. Filed Nov. 23, 1891.

A connector for use between the different cars of a railway train.

Magnetic Extractor, H. W. Southworth, 468,706. Filed Mar. 11, 1891.

A magnetic separator for removing particles of iron and steel from paper pulp.

Rheostat, A. J. Shaw, 468,752. Filed Oct. 15, 1891.

An arrangement for varying the degree of resistance of a rheostat quickly, uniformly and certainly without danger of injurious heating.

Apparatus for Stopping Engines or other Motors, J. P. Tirrell, 468,753. Filed May 11, 1891.

A power-controlling device for steam railways and an electrically controlled detent by means of which the aforesaid device may be prevented from operating.

Railways and Appliances:—

Trolley-Wire Support, J. P. B. Fiske, 468,336. Filed July 30, 1891.

Claim 1 follows:

A trolley wire support comprising a hanger extending along the top of the wire and a sheet metal clip extending below the wire, and clamped to the hanger at its ends.

Electric-Motor Truck, F. O. Blackwell, 468,492. Filed Sept. 16, 1889.

Relates to special means of mounting and supporting the motor upon the truck.

Motor-Gearing for Electric Cars, E. B. Phillips, 468,526. Filed Jan 6, 1891.

Relates to means of balancing the stress of transmission in a motor the axis of whose armature is coincident with the axle of the truck.

Electric-Railway Spstem, W. J. Ogden, 468,575. Filed Nov. 20, 1891.

A single centrally located conductor supplying current to cars running on both tracks of a double-track road.

Electric Railway, C. W. Thomas, 468,708. Filed Oct. 21, 1890.

A trolley having two contact sheaves journaled in a single rocking frame.

Switches and Cut-Outs:—

Combined Switch and Switch-Box, A. L. Rohrer, 468,474. Filed Dec. 2, 1890.

Has specially constructed joints by means of which the switch is made water-tight and at the same time can be readily actuated from without.

Telegraphs:—

Telegraphy, W. F. Wentz, 468,755. Filed Feb. 14, 1891.

Means for reducing the current in the main line, and apparatus for throwing said means into operation upon the opening of the main circuit.

ELECTRICAL WORK AT DU BOIS, PA.

Great activity has been shown of late in electric light and power enterprises in Du Bois, Pa. The Du Bois Traction Passenger Railway Co. has placed itself very rapidly on an excellent basis, thanks to the efficient management of Mr. C. E. Bostwick. Its plant is at present operating three cars which run through the principal streets of the town. The building is a large frame structure 145 by 30 feet. The station equipment at present consists of one 60 kilowatt Edison generator belted direct to a 125 h. p. Ball engine, steam being supplied from a 125 h. p. boiler. The company contemplates increasing the capacity of its plant in a short time on account of its intention to extend the road through other streets of the city, besides running to Falls Creek, a town rapidly developing two miles distant.

Moreover, the Citizens' Electric Light and Power Co. is to be affiliated with the Traction Co., and in the early Spring a fine lighting plant is to be installed of both the arc and the incandescent system.

FRANKFURTER ACCUMULATOREN-WERKE, C. POLLAK & CO.

This company has just been organized at Frankfurt, a. M., Germany, for the manufacture of accumulators, safety mining lamps and other electrical apparatus invented by Mr. Charles Pollak. These cells, which have been declared by the French courts and by experts to be independent of the Faure patents, are claimed to exceed in efficiency and life the usual form of cells. Mr. Charles Pollak is the general manager of the company.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

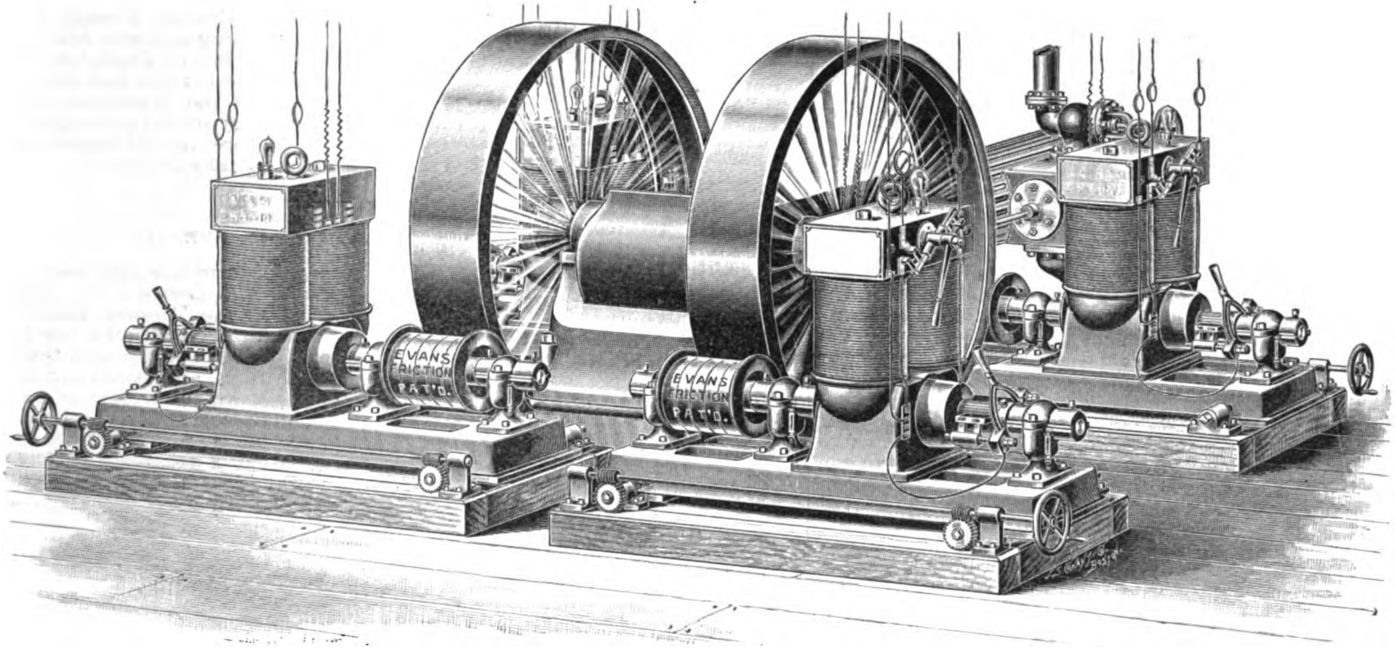
In a good technical journal, the Convention is always going on.

THE CONSOLIDATED ELECTRIC STORAGE CO. SAFETY LAMP.

A portable lamp is manufactured by the above company for the National Transit Co. The case is of quartered oak, 6½ inches high, and 4½ x 2¾ inches in width and depth respectively, and contains the storage battery which may be charged either from a primary battery or direct current. The lamp is of one candle-power, and is hung on springs in the focus of a silver-plated reflector set in front of the case and covered by a bulls'-eye of plate glass. The lamp will burn for six consecutive hours at full candle-power, and the reflector increases the illuminating effect nearly fourfold.

AN EVANS FRICTION CONE DYNAMO PLANT.

We illustrate herewith a plant recently put into the Weeks Building, Boston, Mass., which shows very strikingly the economy in space, and convenience in operation, afforded by the Evans friction cone system of driving, while allowing the use of any dynamo separately. The engraving is so plain as to require little descriptive text. The plant comprises four Edison dynamos driven by the Evans system, in connection with a 200 h. p. McIntosh & Seymour engine.



An Evans Friction Cone Dynamo Plant.

THE EMERSON ELECTRIC MFG. CO.

The first annual catalogue of the Emerson Electric Mfg. Co., illustrating and describing the various specialties of their manufacture, has reached us. Many of the articles shown are entirely new and cannot fail to prove of interest to all users of electrical apparatus. The catalogue has, by way of frontispiece, two excellent half-tone engravings of switchboard installations, while the customary elephant adorns the cover.

THE C. & C. MOTOR COMPANY.

The above company were awarded the contract recently for equipping the large manufacturing building recently erected by J. H. E. Waters, in Denver, with light and motive outfits.

The building is 200 feet square, and at the start will contain a 250 lt. dynamo and a 100 h. p. generator, from which will be operated at once 10 motors of 5 h. p. each, and two of 10 h. p. each.

This will constitute the first large manufacturing plant in Denver.

WRIGHT & STARR ELECTRIC CO.

In the advertisement of the Wright & Starr Electric Company in our issue of February 10, in the sixth line from the top of page xiv, our type made them say that one of the advantages of their system was that "Where the station may be temporarily though totally destroyed it is not necessary to stop travel." By changing the word "destroyed" to "disabled," the true meaning is apparent.

ELECTRIC POWER FOR THE ST. PAUL ROLLER MILL.

Kingsland, Smith & Co., of St. Paul, Minn. write The Electrical Engineer, with regard to the use of electric power in the St. Paul Roller Mill, that they propose to use from 80 to 100 h. p. in all. They expect to use one motor for the rollers, one for the wheat cleaning machinery and one for the bolting and purifying machinery. They have not yet selected their motors.

CHAS. A. SCHIEREN & CO.

The manufacture of leather belting is one of the most important of American industries, not only on account of its magnitude but because its product is in such universal demand in all industries. As is well known the belt is a leading feature in electric light and electric railway work, and the requirements there are often considered to be about as exacting as possible. Leadership in such a field as the electrical is therefore no small thing, but it has been achieved by Chas. A. Schieren & Co., of Ferry street, New York, whose revised and enlarged catalogue, just out, lies before us. Their pure oak-tanned leather belting is in use in electrical plants all over the world, and has won troops of friends, under its name of "Electric" and "Patent Perforated Electric" belting. The new edition of the catalogue is profusely illustrated, and enters in a most instructive and interesting manner into the details of belt manufacture, as practised by this representative house. Readers of The Electrical Engineer will remember the recent able articles by Mr. Chas. A. Schieren on his observations abroad as to European belting, and on reading this pamphlet they will at once perceive how thoroughly the long experience indicated by the articles has entered into every detail of his own work. In addition to the illustrations and descriptions of belt manufacture, there is some valuable information as to methods of power transmission by belts—a section that any central station manager can study with advantage. The catalogue also contains a number of minor features and a telegraphic code.

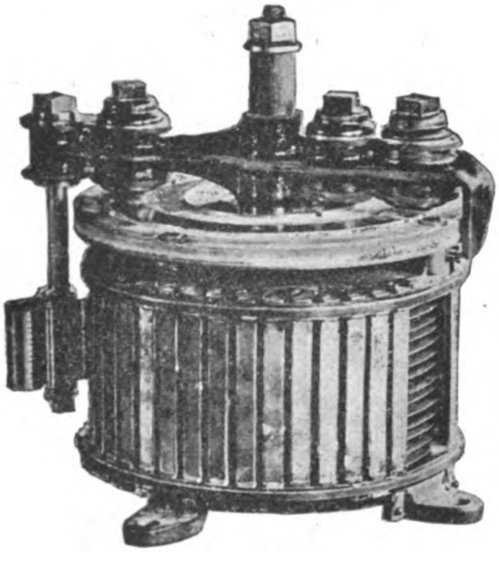
DETROIT ELECTRICAL WORKS.

The Detroit Electrical Works are making extensive preparations in their supply department for this season. A very large addition which they are building to their already extensive factory is evidence that they intend to keep pace with the electrical fraternity.

They are bringing out several new features in this department to be ready for the market in the course of three or four weeks.

NEW EDISON ELEVATOR CONTROLLER.

The Edison General Electric Company have recently designed and are bringing out a new controlling rheostat for use with electric motors running elevators, hoists, and in other places where the conditions require that the motor be started, stopped and reversed continually. The controller consists of a resistance box of special form, as shown in the engraving. By the movement of a lever, resistance can be gradually thrown in or out of the motor circuit as required, thus increasing or diminishing the speed of the motor. The lever also carries the contacts required for reversing the motor. This controller can be employed with either shunt or series wound motors, and possesses the great advantage of an arrangement whereby, before the motor can be reversed the whole resistance is thrown into the armature circuit. By this means the possibility of burning out the armature by too sudden reversal of the motor is prevented, and fluctuations in the voltage of the line wires, by too swift an accession of power, reduced to a minimum. The controller is constructed to carry continuous currents of 15 amperes with all the resistance in circuit, but currents up to 60 amperes can be passed through it, without injury, for a short time, when starting the motor. The contact lever can be worked by a handle or a pulley wheel, as conditions require. For elevator work, it is fitted with a pulley, around which passes the steel rope which, in the hands of the elevator man, controls the movement of the elevator.



New Edison Elevator Controller.

The resistance consists of a continuous series of sheet-iron convolutions with mica insulation between the convolutions, divided into sections, each of which is connected to a vertical brass bar arranged around the iron convolutions, so that a special contact shoe on the lever arm makes a perfect frictional and flexible contact with the brass bars. The lever operating this contact shoe works over a slate table fitted with brass rings for the main and armature connections. Carbon contacts are used on these rings. As iron, brass and mica are the principal materials used in the construction of the controller, it is able to withstand a very high degree of heat, without risk of destruction. A space 2 feet 2 inches and 1 foot 10 inches high is required for the controller.

This controller takes the place of the older motor rheostat, and its novelty of form and many advantages which it offers, should bring it into considerable requisition in places where the older and more cumbersome styles have hitherto been used, and should make it essential in all new installations of electric elevators or hoists.

THE SHORT GEARLESS MOTORS IN SNOW.

It appears to be a curious and interesting feature of the Short gearless motor that it will operate perfectly during snowstorms, maintaining the schedule time, where other motors fall rapidly behind. The only reasonable explanation of this is found in the fact that the weight of the motor is centered directly over the axle, so that maximum traction is attained. In support of this theory, it is noticed that the wheels of the gearless motor rarely or never slip even under the worst conditions of track. Another reason is probably found in the special controlling device used by the Short Co. which prevents a sudden rush of current through the motors, which frequently starts the wheels to slipping and prevents them from taking a good grip on the rail. That this latter explanation has some weight, is proven by the fact that the Short double reduction motors have operated during the past month under conditions of track and weather where other motors of the same type have completely failed. In Braddock, Pa., two 15 h. p. Short double reduction motors are operating cars on 12 and 13% grades during heavy snow and sleet storms, and without missing a single trip. The other road in the town, operating also with double reduction motors, was tied up.

In Cleveland, two Short motors carried a car through 4 or 5 inches of unbroken snow, over a disused switch and started up without difficulty under the same conditions. The gearless cars in Cleveland are the only ones which can keep on time, and the same is true of the long double truck gearless motor car which has now been running for nearly three months in St. Louis, Mo.

In Jamestown, N. Y., the Short double reduction motors have operated right through the heavy snowstorms over a succession of grades varying from 6 to 10% with sharp curves, and the railway people are surprised and delighted at their performance.

CROCKER-WHEELER MOTORS IN ENGLAND.

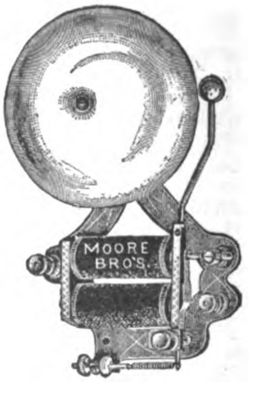
The Crocker-Wheeler Electric Company, New York, has just shown a full line of motors, fan and pumping outfits, automatic switches, etc., at the Crystal Palace Exposition through their agents, the General Electric Company, Ltd., of London, and have come off with flying colors. The General Electric Company now have in writing from Messrs. Crompton & Co., makers of the excellent English dynamos and motors, that their various attempts at making small motors have been failures when compared with the machines put upon the market by the Crocker-Wheeler Electric Company. They have also made arrangements with the General Electric Company to publish a list of Crompton and Crocker-Wheeler motors. One part of the list will deal entirely with the Crocker-Wheeler motors and on the frontispiece they state that they have taken up their sale by special arrangement with the General Electric Company, who are the sole representatives of the Crocker-Wheeler Electric Company in London.

ELECTRIC CONSOLIDATION ABROAD.

Under the firm of Union Electric Co. there has just been organized in Berlin a company consisting of L. Loewe & Co., Thyssen & Co., Mulheim-on-the-Rhine; and the Thomson-Houston International Electric Co., of Boston. The new concern has acquired all the patents and rights of the Thomson-Houston International Electric Co. for Germany, Austria and Northern and Eastern Europe. The company does not intend to erect its own factories, but will have its entire manufacturing done by Loewe & Co. The capital stock of the new company is 1,500,000 marks, equally distributed between the three contracting parties. The company will devote special attention to the introduction of Thomson-Houston apparatus, both for lighting and power purposes.

THE MOORE ELECTRIC BELL.

The Moore Electrical Manufacturing Company, of 652 Hudson street, New York, are introducing a special type of electric bell of which our illustration is a good representation. This bell is an exceedingly sensitive one, fitted as it is with a pivoted armature it is possible to produce a positive vibration of a large bell having a 10-inch gong with the current of one cell of Leclanche battery. The bells are made up to a gong of 20 inches diameter and are so constructed that they will work on either an arc or incandescent circuit if desired. This company issue a neat descriptive catalogue illustrating the specialties manufactured by them.



The Moore Electric Bell.

THE COWLES WATER-TUBE BOILER.

Recent progress in engine design for large stationary power plants calls for double the steam pressure now ordinarily in use and creates an absolute necessity for some well-designed form of water-tube boiler which will meet the very trying conditions presented. Both ashore and afloat the engine-room is now far in advance of the fire-room. We have excellent triple and quadruple engines in regular commercial use calling for 160 to 200 lbs. of steam and the efforts to furnish the steam for these machines with the old types of boiler are very far from satisfactory. The tendency now is to duplicate the modern steamship plant in the large electric lighting and traction stations of the country, and to do this it becomes more and more necessary, as the pressures increase, to use water-tube boilers.

The Cowles water-tube boiler represents, perhaps, the latest successful attempts to meet this increasing demand for progress in the safe and economical generation of steam for high pressures.

The accompanying engravings show plainly the design and construction of this boiler. Special attention has been paid to strength and safety and to a perfect circulation, not only of the water and steam in the boiler, but of the gases passing around the tubes. The very important question of accessibility for cleaning, inspection and repairs has also been given thorough attention. For stationary work the boiler is enclosed in masonry, and for marine or portable work it is jacketed throughout with a steel shell casing lined with a non-conductor and fire tile supported by the tubes. The boilers are built in several sizes ranging from units of 500 h. p. and three inch tubes, for large shore plants and steamship work, down to 25 h. p. and 1½-inch tubes for light work, such as yachts, and for portable use. The tubes are of the best boiler tube manufacture, bent cold to easy curves in a special machine and expanded in; the shells are of the best mild steel, and the heads and manhole plates are of hydraulic-pressed steel. The heavy pipe and malleable fittings are so designed and arranged that they are in no part exposed to the fire or heated gases. The tubes can be thoroughly swept outside and cleaned by a flexible scraper or brush inside. Any tube can be plugged, or entirely removed and replaced without injury to another tube, and access for this work can be had entirely through the uptake, furnace doors and manholes.

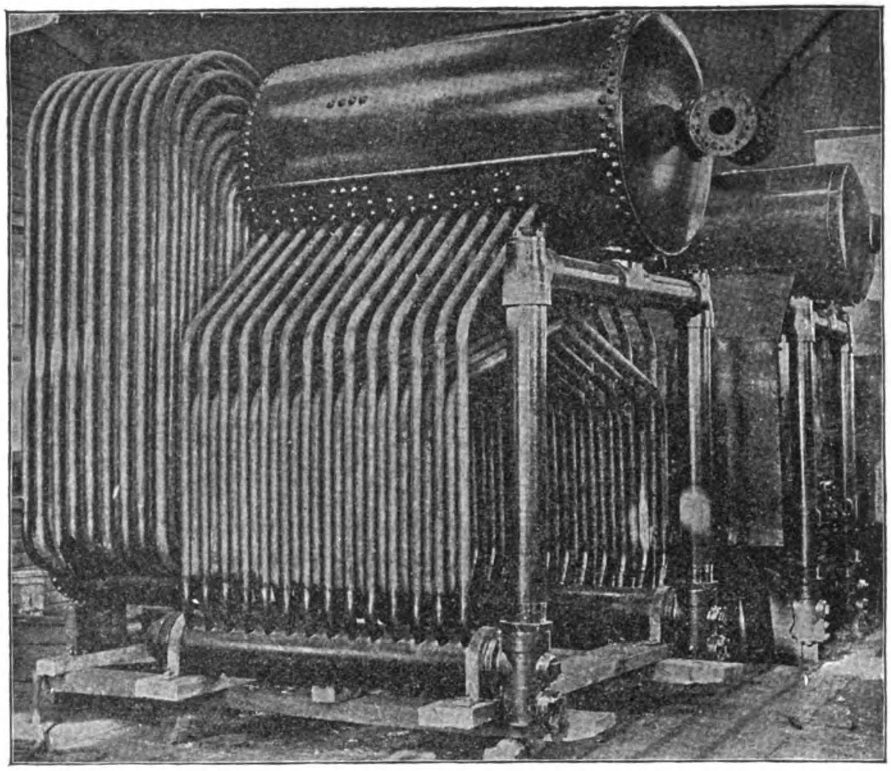


Fig. 1.—The Cowles Water-Tube Boiler.

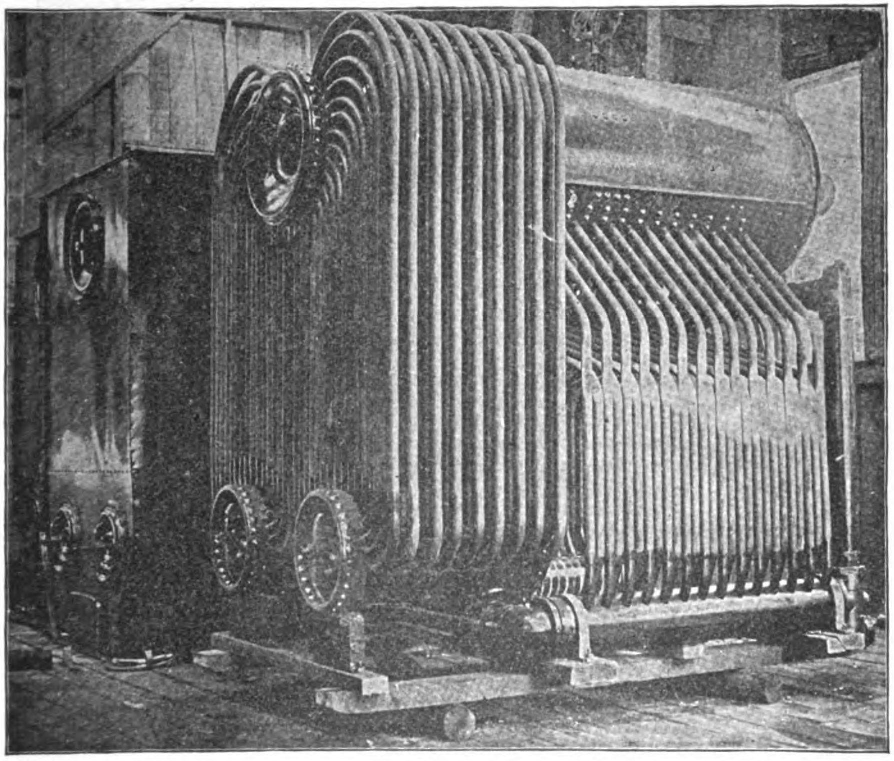


Fig. 2.—The Cowles Water-Tube Boiler.

The Cowles Engineering Co. (foot of 43d street, Brooklyn, N.Y.), claim that it is impossible to injure the boiler by unequal expansion or overheating, and that it is far safer with a working pressure of 200 lbs. than the old style of shell boiler with its 100 lbs. pressure.

CROCKER-WHEELER ELECTRIC CO.

Although there is to be no regular exhibition at the Buffalo Electric Light Convention, the Crocker-Wheeler Electric Company will have a number of motors set up and running at the office of their Buffalo agents, Messrs F. P. Little & Company, adjoining the Broezel House. Messrs. Otis Bros. will also have one of their celebrated pumps operated by a ½ h. p. C. W. perfected motor, and their latest Crocker-Wheeler automatic switch.

ELECTRIC HEATERS ON THE OMAHA STREET RAILWAY.

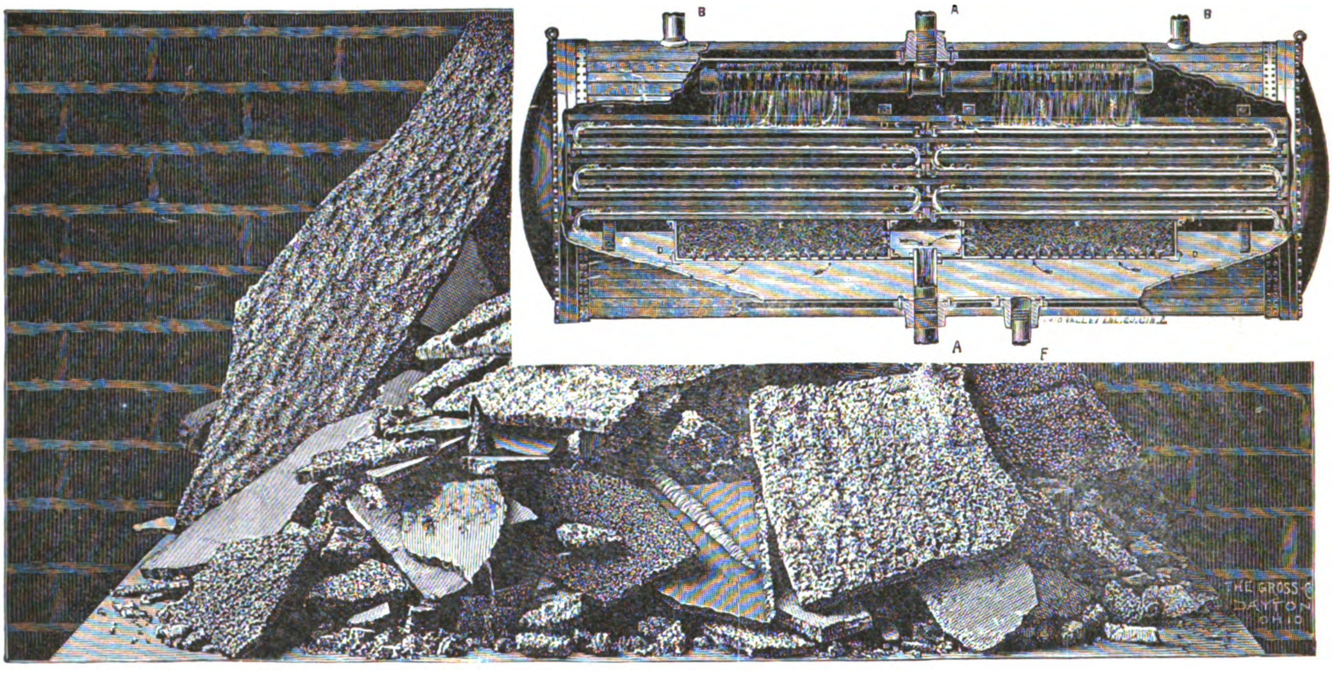
We have recently received some interesting figures in regard to the use of electric heaters on the electric cars of the Omaha Street Railway Co. It appears that per set of 4 Burton heaters to the car, 2 h. p. is required in the shape of current, or 4 lbs. of coal per h. p. hour, or 144 lbs. of coal per day of 18 hours. Coal costs the company $1.75 per ton, making 1 lb. cost .00087 dollar, or 144 lbs. cost .12528 or 12¾ cents per car per day. The company's experience with coal stoves has been that they cost them 25 cents a day.

Mr. Robert C. Hull, formerly of the Thomson-Houston Works, at Lynn, has accepted a position in the engineering department of the Thomson-Houston Electric Light Company, at Philadelphia.

STILWELL'S PATENT LIVE STEAM FEED WATER PURIFIER.

In many instances it is for various reasons impracticable to use an exhaust steam heater, and to meet emergencies, the horizontal live steam purifier, shown in the accompanying illustration, was expressly designed by the Stilwell & Bierce Manufacturing Co., Dayton, O. In mode of operation it is similar to the upright live steam purifier, but its mechanical construction is quite different.

As will be observed, it is a horizontal cylinder, made of best steel boiler plate, and may be placed in any convenient locality above the boilers to be supplied and with which it is directly connected. The cold water, or water from exhaust heater, is introduced at A through a pipe connected by a tee with a horizontal pipe inside the shell. Both ends of this horizontal pipe are perforated with many small openings, through which the water escapes in the form of a shower. Live steam is admitted at B B, filling the purifier with steam at boiler pressure. The water falls from the induction pipe through a body of steam into the top of two series of shallow iron pans, each pan being one-half the length of the purifier shell. These pans are provided with openings in the bottom at alternate ends, and the water is compelled to traverse their entire area in a thin sheet. As the heat and pressure in the purifier is the same as in the boilers, the water, in its passage over these pans, is subjected to the same chemical change as in ordinary boilers, and is relieved of all scale-producing impurities, which are precipitated upon the surface of these pans from which they can be quickly and easily removed. After passing the circuit of the pans, the water drops into the large settling chamber D D, in the bottom of the purifier, where the non-crystalized impurities deposit in the form of slush or mud, and are blown off at frequent intervals through the blow-off F. To complete the work of purification, the water passes through the filtering chambers E E which are filled with coke or other suitable material, into the pure water chamber, and thence into the boiler through pipe A.



Stilwell Purifier and Impurities Retained by It at Dayton, O.

It is claimed that the feed water is then absolutely pure, and at substantially the same temperature as the water in the boiler, thus effectually preventing the deposit of sediment in the boiler, and the strain upon it incident to the introduction of water at a low temperature.

Each end of the purifier is provided with a heavy head fastened in place with cap screws. The depositing pans slide on ways which are fastened to the shell and can easily be removed through either end of the shell for cleaning, and any impurities which may attach to the bottom of the purifier shell can readily be raked out, as removing the head exposes the entire inner structure.

A forcible reminder of what impurities are contained in ordinary feed-water for boilers is afforded by the engraving of a heap of lime deposits retained in a Stilwell live steam purifier in use on the boilers at the City Water Works, Dayton, Ohio.

Mr. H. T. Bierwirth, city electrician at Lincoln, Neb., has resigned to accept a similar position at Omaha.

COBB, DANBY & KNOTT; CHANGE OF FIRM NAME.

The resignation of Mr. Danby from the firm of Cobb, Danby & Knott has necessitated the changing of the firm name. The new style will be Cobb, Smith & Knott, Mr. Eugene M. Smith having taken a place in the firm. This gives the company a complete electrical and mechanical force.

Cobb, Smith & Knott have been awarded the contract for furnishing the entire electrical outfit for the Edison Illuminating Co., of Coney Island. Mr. Cobb has been appointed consulting electrical engineer and Mr. Knott consulting superintendent of construction. The plant to be installed is to consist of a Wood system 200 arc light machine and a 4,000 incandescent light Edison plant.

THE GRAPHITE LUBRICATING COMPANY.

The Graphite Lubricating Company, of Bound Brook, N. J., have completed a desirable and well-equipped factory in this thriving town of Central New Jersey. With their increased facilities they are now in a position to accept and turn out on shortest notice, all business in their particular line with which they are entrusted. They are in receipt of large orders for their dry Graphite lubricating trolley wheels for electric cars. A special feature in their new trolley wheels is the invention of Mr. Bache, superintendent of the factory, and consists of a specially cast hub into which the grooved bushings are placed. The hub is cast with a chamber surrounding the bushing. In this space is placed powdered graphite which feeds through very small holes directly onto the shaft, keeping an automatic feed of dry lubricant on the shaft at all times.

The company have their own well-appointed brass foundry where all castings for their special work are made. They are at present turning out a large number of specially constructed bearings for street car motor armatures with special graphite feeders. These bushings are used entirely by the Detroit Electrical Works and are giving excellent satisfaction. The shafting of the entire factory runs in the graphite lubricating bushings and, in some cases, has been running continually since the 1st of July, 1891, without change or the use of a particle of lubricating oil.

A LAVA SHIELD FOR ARC LIGHT CARBONS.

Mr. D. M. Steward, of the D. M. Steward Manufacturing Company, of Chattanooga, Tenn., is now on a trip North, and while in this city recently showed us among other interesting pieces of lava insulation, an arc light carbon shield. It had been in use continuously upon a carbon for thirty hours, and during part of that time may be said to have been actually around the upper portion of the arc. It was fractured on being taken out, but appeared likely otherwise to last for an indefinite period. With such wonderful material as this lava as a shield single carbon lamps ought, to put it paradoxically, to burn longer than the double.

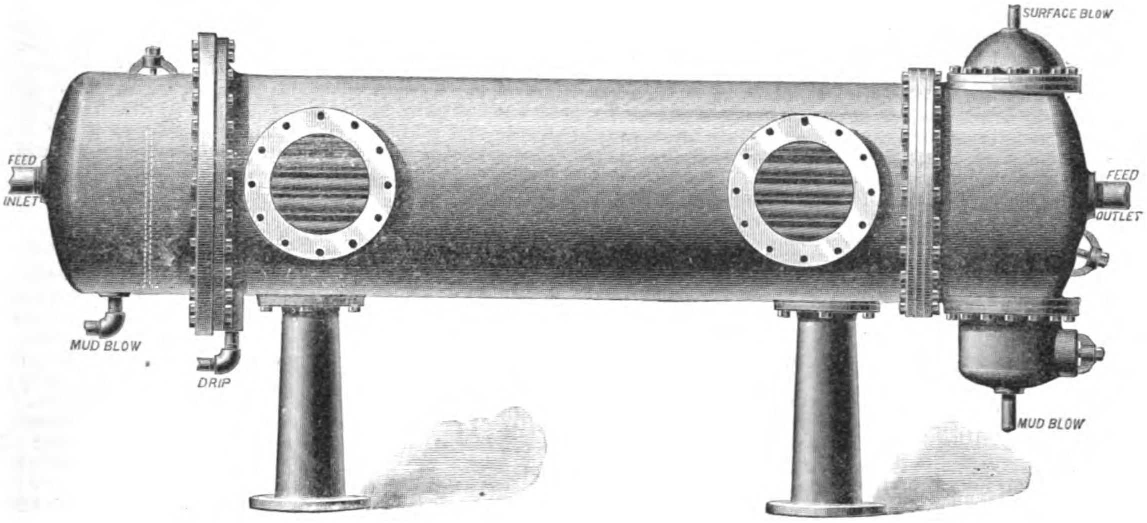
THE GOUBERT HORIZONTAL FEED-WATER HEATER.

The Goubert Manufacturing Company, of 32 Cortlandt street, have lately introduced a new horizontal feed-water heater, shown in the accompanying illustration. It is designed to meet the difficulty of insufficient head room often encountered where the cellars of city buildings have to be utilized for the location of the steam plant.

This horizontal heater is also specially adapted for use in connection with condensing engines, as the steam nozzles can be placed in any position required; the inlet nozzles may be directly under the engine exhaust and the outlet nozzle bolted to the top of the condenser. This arrangement practically taking the place of the exhaust pipe, making a very neat connection.

The heater is shown on the engraving as resting on a pair of columns, but it may be provided instead with lugs or bolts, or straps, to be hung from the ceiling; or it may be supported by beams or saddles.

The manufacturers have preserved in the horizontal heater all the advantages of construction that have made their regular vertical heater so successful.



The Goubert Horizontal Feed Water Heater.

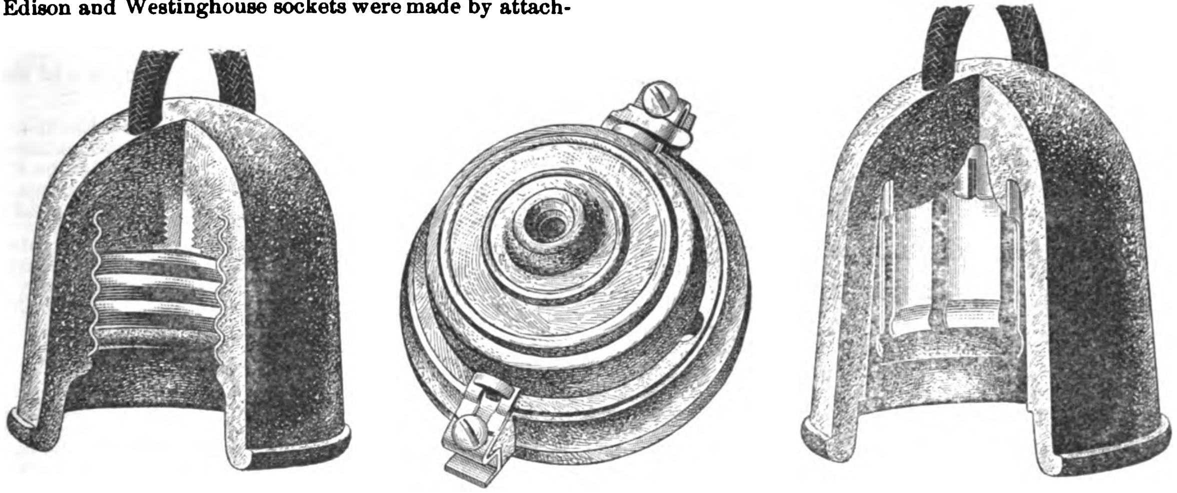
GOULD & WATSON SOCKETS.

The Gould & Watson Co., of 35 Hartford St., Boston, have just completed improvements in their keyless waterproof sockets. Formerly Edison and Westinghouse sockets were made by attaching extensions to the Thomson-Houston socket, which did not produce a waterproof article, although otherwise satisfactory. The success in the Thomson-Houston sockets has led this firm to bring out an Edison and a Westinghouse socket, which are so constructed that, by the introduction of a rubber washer, lamps may be burned under water with perfect safety. This is an interesting improvement, and one which is likely to meet with general approval. The sockets as now made are compact, and the brass parts are moulded entirely within the socket.

The wires are also changed in their mode of attachment so that there is considerable space between them, and this prevents the gathering of moisture and rotting of the wire at the point of entrance into the socket. All these points will be readily appreciated, and the attention of visitors to the Electric Light Convention is called to the exhibit of these goods, and also to the Smith rosettes manufactured by this firm.

In the accompanying illustrations, Fig. 1 shows the Edison, and Fig. 2, the Westinghouse socket, both of which are designed to carry shade holders. Fig. 3 shows the Smith rosette, the price of which has been reduced so that they are claimed to compare favorably with any rosette in the market. The wiping joint at the point of attachment is also of valuable consideration.

Mr. Edward P. Sharp will be in attendance at the Convention, and will be pleased to show samples of these goods, and explain their features.



Figs. 1, 2 and 3.—The Gould & Watson Waterproof Sockets and Rosette.

THE SAMSON CORDAGE WORKS.

The Samson Cordage Works of Boston are building some new braiders for the manufacture of the Samson arc light cord, as the demand for this article has been greater than their capacity to supply. The new machines are of somewhat different pattern from the old ones and are considered quite an improvement. This cord is made from the very best cotton stock, free from waste, and its tensile strength has been shown by careful tests to be very high. Its durability is considerably increased by the waterproof finish which the manufacturers apply at a slight additional expense, and it is much the most desirable cord for hanging arc lamps, as well as for trolley cord and magnet cord. The manufacturers are glad to send samples of the various sizes, and full catalogue with discounts.

Mr. John Earles, manager of the Kaukauna, Wis., Electric Light Company is to sever his connection with the company at the end of this month.

THE KNUDSON CUTTRISS WIRE CO., "LIMITED."

THE above company has been organized under the laws of the State of New York. It is the owner of patents granted to A. A. Knudson and Charles Cuttriss for a new insulated *fibre* wire. The points in its favor over other wires of this class are claimed to be as follows:

1st. A new and simple method of applying the cotton in its raw state, thereby saving the difference between the price of the raw, and the yarn, at the start, and, also the difference in the time and labor; as one process only is needed, against several of braiding in order to get the required amount of cotton on the wire.

2d. An insulating material which, while being cheaper than the most that is used on the ordinary so-called weatherproof wires, tests very high. Samples which have remained under water from three to six weeks show a resistance from 100 to 200 meghoms per mile.

The cost of manufacture, therefore of this wire will be less than that of other fibre covered wires, it is claimed, while its excellent insulating qualities should commend it to the trade. Other features of excellence are low inductive capacity, non-abrasion, and resistance to atmospheric changes. A cheap and excellent cable for telegraph, telephone and other uses can, it is said, be made with this process. Any information regarding rights to manufacture under the patents controlled by this company can be obtained by addressing Mr. John F. Zebley, president, Rooms 37-38 Drexel Building, New York.

THE WASHBURN-MOEN COMPANY.

A RECENT special feature at the factories of the Washburn-Moen Company, Worcester, Mass., has been the putting in of a special plant for the insulating of all sizes and grades of wire. This department is now in full working shape and the company are prepared to accept and fill all orders promptly.

THE ENGINEERING EQUIPMENT CO.

AMONG the more important February announcements is that of the contract made between the Engineering Equipment Co. of New York and the Gould & Watson Company of Boston. The former have become, under exclusive privileges, the sole sales agency in the East for "G. & W." line materials. Purchasers of these materials will find the Engineering Equipment Co. prepared to give manufacturers' terms, as on the other lines they handle, and to fill orders from stock without delay. New designs, added to standard styles now selling largely, offer to roads and contractors an attractive variety of materials of this well-known make and samples are now shown which none interested should fail to see. Mr. W. F. D. Crane, M. E., has charge of this department at the Engineering Equipment Co.'s New York offices, 143 Liberty street; and at 126 Pearl street, Boston, Mr. F. A. Magee, M. E., represents the company on all their lines of electric railway materials.

"THE PENNSYLVANIA LAMP."

THE manufacturers of this lamp are convinced that they have an excellent article, and are now busily engaged in converting the rest of the community to the same belief. A description of the lamp, together with some results of a recent test, was given in the last issue of THE ELECTRICAL ENGINEER.

NEW YORK NOTES.

MR. H. C. WHITNEY, late of the Consolidated Electric Storage Company, and previously with the Crosby Electric Company, has just closed with the Union Electric Company of 45 Broadway, to represent them in this city. Mr. Whitney's experience in the battery business has been thorough and extensive, involving thousands of miles of travel for the companies with whom he has been connected, and incidentally giving him the advantage of a wide and intimate acquaintance with the trade. With the acknowledged future which awaits storage batteries in general and the special merits of the battery manufactured by the Union Electric Company, Mr. Whitney's success would seem to be assured.

THE completing of arrangements whereby the price of the Security insulator has been very much reduced and the manufacturing facilities increased, has had the effect of bringing in large orders. Mr. Brown, the manager of the company, is receiving some exceedingly congratulatory letters from those who have used the insulators. The offices are located in the Electrical Exchange Building, this city.

BALTIMORE NOTES.

MR. ELIAS E. RIES, president of the Ries Electric Specialty Company of Baltimore, Md., will make his headquarters at the Iroquois during the Convention, and an opportunity will be offered to the central station men, etc, to see the Ries regulating socket in operation, and to receive a full explanation and all details relating to the many advantages offered to the general electrical public by the Ries regulating socket for alternating current incandescent lamps. It would be well for every visitor to the Convention to look this exhibit up, so as to become familiar with the Ries regulating socket, as it is certainly destined to play an important part in the incandescent electric lighting system of the present and future

The Ries Electric Specialty Company will shortly increase their capital stock to $150,000. Some very valuable specialties have been lately acquired by this company, and in order to increase their facilities to meet the rapidly increasing demand for their goods, it was decided at the last meeting of the board of directors to issue stock to the above amount, of which $50,000 will be preferred and will bear interest at the rate of 6 per cent. Most of the new issue has been already subscribed for, and there is no doubt but that the balance will be speedily taken.

WESTERN NOTES.

THE ELECTRIC MERCHANDISE COMPANY, Chicago, has the past week filled an unusually large order for its own insulating tape. Being of an extra heavy weight and having unusual strength, it is found especially well adapted to street railway needs. Appearances at 11 Adams street, the head-quarters of the company, tell the tale of another season's advent, apparently a lively one. Large lots of all manner of electric railway supplies for use upon all the different systems are being added to its stock, placing the company in an enviable position for the opening of the spring business. Owing to the tendency of street roads to use heavier equipment, additional strength has been given to many of the devices furnished by this company with a view to furnishing, as heretofore, material first-class in every particular.

THE POND ENGINEERING CO., owing to the increase of business in their Chicago office, have found it necessary to move from the offices 427 and 429 the Rookery, which they have occupied for the last three years, and are now to be found in Room 8 the Rookery. This is one of the best offices in this well-known office building, and the Pond Engineering Co. are having it fitted in an elegant manner, with a view to the best accommodation of themselves and their patrons. Room 8 extends from the rotunda to the Rookery court; the front part will be devoted exclusively to office use, and the rear for drawing-room, shipping, etc. The many friends of the Pond Engineering Co. will doubtless be pleased to learn of their new move, and visit their new quarters.

MR. THOS. G. GRIER has published in pamphlet form a nice little set of tables for wiring for motor circuits. The first table is arranged to show the amperes per motor at certain efficiencies for various horse powers and voltages. A separate table shows the minimum size of wire for motor services and a final table designates the wiring for various losses, giving horse power, ampere capacity, safe-carrying capacity, diameter, gauge, number, etc., and full particulars for determining any size of wire for any required motor circuit.

MR. WILLARD W. LOW, president of the Electric Appliance Company, has just returned from an extensive business trip, and reports that while he finds business rather quiet, he did not let a single day go by without sending in something substantial in the way of an order, and had on the whole a very successful trip.

THE STEARNS MANUFACTURING CO., of Erie, Pa., are installing two "Woodbury" engines of 75 h. p. each for running the electric lights in the B. & O. depot at Pittsburgh. They also put in two 100 h. p. engines at the Brighton Hotel, Atlantic City, electric light plant.

SOUTHERN NOTES.

DALLAS, TEX.—Mr. Chas. Q. Harris, so long known in the Southern electrical field as a consulting and contracting electrical engineer is again actively engaged in business. He will represent the National Elec. Mfg. Co.; the Consolidated Elec. Mfg. Co.; the Electric Merchandise Co.; Holmes, Booth & Haydens; Geo. Cutter; Peru Glass & Carbon Co.; the Electric Gas Lighting Co.; the Ernest L. Clark Co. and others.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
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ALTERNATE CURRENT MOTORS.[1]

BY WM. STANLEY, JR.

It is not my purpose in the present paper to enter minutely into the details of the various attempts that inventors have made to produce an operative motor. As far as I know, the first work on alternate current motors in this country was undertaken at Great Barrington, 1886 and 1887, when I designed and built a synchronous motor, and a motor acting under the repulsive currents obtained by periodically short circuiting armature coils, while they were under the induction from the field. One of these motors was designed in January, 1886. Professor Thomson, in 1887 and 1888, also produced motors of this type, and, what was of still more importance, he read a paper before the American Institute of Electrical Engineers memorable for the clearness with which he treated the subject.

The various plans suggested by inventors and by engineers may be classified into three types, they are: First, motors operating in synchronism with the current alternations, having a field magnetization, produced by continuous currents with alternate currents applied to the armature circuits, a type originally demonstrated by Hopkinson in 1883; second, motors actuated by the inductive effects of a rotating field upon closed armature circuits, first suggested by Mr. Tesla in 1887; and, third, motors operated by alternate currents, in both field and armature, constituting one of the types investigated by Mr. Kelly and myself.

While many inventors were eagerly following their various lines of investigation for the purpose of producing an operative motor, Mr. Tesla had quietly worked out a new solution of the problem on an entirely novel basis, by inventing the rotating field, that is, the field produced by shifting magnetism, and producing it by alternate currents. Mr. Tesla's motor is so simple and so beautiful in theory that many have doubtless wondered why it has not been brought into general use. If I correctly understand the subject, it has not been commercially adopted because of the difficulties in operating it at the frequency generally in use in this country, viz., 130 ∼ p. s., and especially because thus far special generators and circuits having phase differing currents must be employed; there have been attempts to subdivide alternating currents into two or more currents differing in phase. Special arrangements of condensers for producing phase differences from a single source of supply have been worked out by M. Leblanc, in France, and by Mr. Kelly in this country. As regards the motor itself, there are two drawbacks to its use which have not thus far been entirely removed; they result from the inductive effects of the currents upon themselves and upon each other.

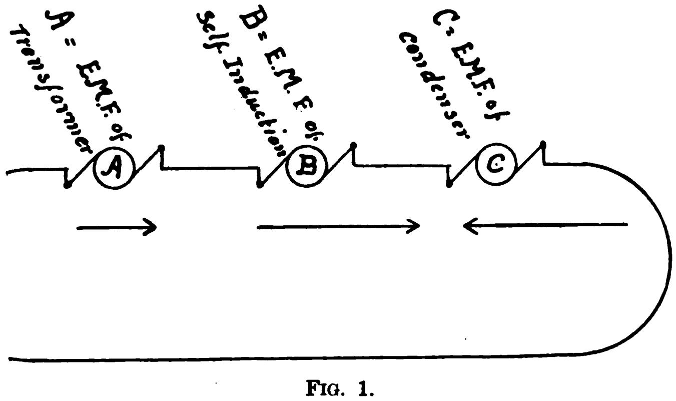

FIG. 1.

Mr. Kelly and I have invented what we call a "condenser motor," which differs radically from either of the above mentioned types. The problem which we have had in mind was to construct a motor which should be operated by existing alternate currents in exactly the same manner that we operate an ordinary motor when supplied with continuous currents; to do this, it is necessary to construct a motor whose circuits do not possess (effective) self-induction, or, to put it in another way, it is necessary to take away from the alternate current circuits the effects of the E. M. F. induced in them by their own currents, which render unavailable a considerable part of the E. M. F. applied.

I will attempt to explain our shunt motor without the use of formulæ, illustrating the results obtained as best I can.

Our motor has a laminated sheet iron field, and may be made in any of the multipolar or bipolar types. The field winding is connected in series with a condenser to the secondary of a transformer, which, when fed from the station, furnishes the source of supply. The armature of the motor, although wound with a special winding, is substantially the same as a continuous current armature, and is surrounded by closed copper bands whose function I will describe later. The theory of the motor is, that, given the necessary magnetization and armature current, the motor will operate as well with alternate as with continuous currents. Returning to the field circuit, let us glance at the function of the condenser. If the field windings were connected directly to the transformer or source of supply we should have two E. M. F.'s in circuit, combining to oppose the E. M. F. applied by the transformer.

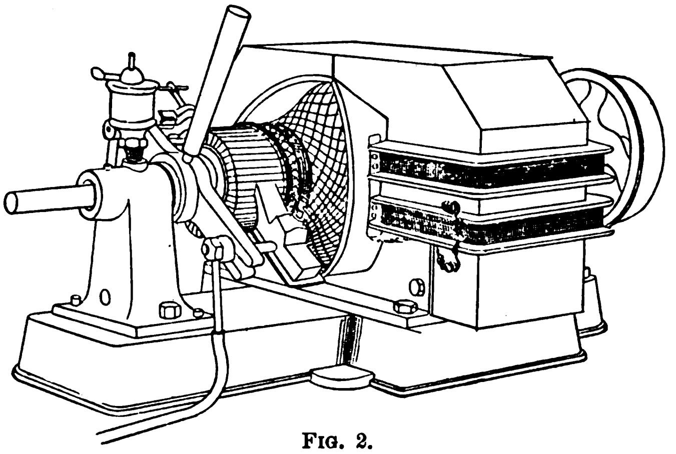

FIG. 2.

This may be made simple by considering the resultant effects produced by a number of alternators coupled in series, Fig. 1. Let A, B and C be these generators; let them be all rigidly coupled to the same shaft, A being set on the shaft so that its armature generates an E. M. F. 90 degrees away from that of B and C, while B and C are coupled to produce the same voltage at the same time and have their terminals opposed; then B and C will exert no effect upon the circuit, for they will always neutralize each other. The E. M. F. of A corresponds to the transformer E. M. F.; the E. M. F. of B to the E. M. F. of self-induction on the field coil, and the E. M. F. of C to the E. M. F. on the condenser. In this way we obtain the necessary current to magnetize our motor unrestrained by the E. M. F. of self-induction.

Had we a reliable means of dividing an alternate current into two currents having the proper difference of phase, Mr. Tesla's motor would be made available and would be of great commercial value. Mr. Kelly and myself have found an entirely novel and complete solution to the problem. As far as we can discover, it has never been attempted by any other experimenters. By the use of a very simple invention, we are able to draw from a single transformer secondary two phase-differing currents, having any differences of phase we elect. These currents maintain their phases, that is to say, times of flow, independent of the amperage of the current and of each other. We can apply our invention at the station, splitting the primary current from the dynamos into two phase-differing currents, or we can lead the primary current through a transformer and split the secondary into two components.

I regret that I am unable to disclose the methods we adopt, but I hope to be able to publish our results shortly. Our method will then allow us to run the Tesla motors from the same circuits and by the same generators that we now employ in incandescent alternate current lighting. The Tesla motor for the past five years has been waiting for one thing only to develop it, viz., a current splitter, and we have found one.

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[1] Abstract of a paper read before the National Electric Light Association, at Buffalo, Feb. 24, 1892.

The next difficulty to clear up, in order to operate our motor, is to get rid of the external resistance in the armature circuit. In order that a motor may operate economically and regulate properly for changes of load and current, it is desirable that the armature resistance should be very low; the principal resistance offered to alternate currents in an armature is, as before stated, due to the work outside of the armature wire in the iron core; these losses in the iron are occasioned by the alternating magnetization developed by the armature current; to remove this loss of energy we have had to destroy most all of the armature magnetism in the following manner:

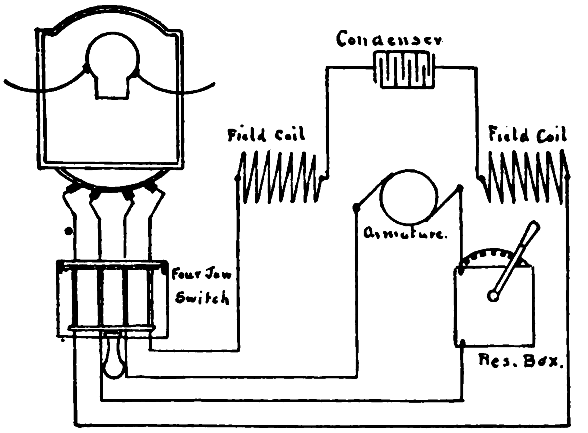

FIG. 3.

You are all aware that if a magnet core is wound with two equal coils in opposite directions and is connected with a current source, the resulting magnetism will be only that due to the difference of the winding displacement, and will be practically negligible. About our armature, see Fig. 2, we place close circuited copper bands or wires, so disposed as to be parallel to the direction of current flow in the armature conductors; the currents flowing in the armature windings induce oppositely directed currents in the stationary bands, and, consequently, the armature core is surrounded by two sheets of current during each wave of current flow, the sheet of current on the armature flowing in one direction, whilst the current in the stationary bands flows in the opposite direction, thus practically preventing any magnetizing effect, and thus, also, preventing any loss by hysteresis and eddy currents in the core. Now, it can be shown that the work lost in the copper bands will be very small, provided the resistance of these bands be kept low, and we have found that this loss can be made as low as one-third of the inside or ohmic loss, a result which enables us, by proper designing, to make our armatures almost as efficient as those of the best direct current type, with small additional expense.

One other point of advantage obtained by the use of the compensating bands should be mentioned. As the cross magnetization of the armature is practically destroyed, there is no change of lead under variation of load as there is no distortion of the field magnetism by the armature current. These results are eminently satisfactory. In our motor 96 to 98 per cent. of the voltage applied to the armature is available, while the operating conditions are identically the same as found with a continuous current motor. It is not to be understood that the motor has an efficiency of 96 to 98 per cent. Far from it. In our small motors the losses in the field and armature will aggregate 30 to 40 per cent. In the larger types of from 2 to 5 h. p. the loss will not exceed 25 per cent., whilst in the still larger sizes the losses will be much less. The problem of the efficiency of the motor is almost the same as the efficiency of the transformer and depends in large measure on the care and skill of design.

To operate our motors it is necessary that the speed of the dynamo should remain constant; as constant as possible. If the stations will give us a definite number of alternations, and will maintain that number, our motors will behave beautifully; if the alternations change, the condenser electromotive force will no longer exactly oppose the lagging electromotive force of self-induction and the field current will change and lag either positively or negatively; mere change of electromotive force will not interfere with the operation of our motors more than it would with any continuous current motor.

Fig. 3 illustrates the general design and arrangement of the motor system. The condenser is placed either upon the wall or under the motor in the base; the E. M. F. applied to the field is about 150 volts; the armature E. M. F. is either 50 or 100 volts. The E. M. F. on the condenser is, approximately, 750 volts; while this E. M. F. may appear excessive at first sight, there is no real danger from its use, as a contact across the terminals would instantly reduce the potential and accidental contact is easily prevented by properly insulated wires.

There is one other type of motor to be mentioned; the series wound motor. When operating a motor by alternate currents, the magnetism in the field should coincide with the E. M. F. applied to the armature, or else there will be a false current in the armature circuit; the condenser accomplishes this desired result in the shunt type of motor. In the series wound motor the magnetization necessarily coincides with the armature E. M. F., because they both accompany the same current. Fig. 4 represents a motor having its field and armature connected in series, while *c* is a condenser also connected in series; the distribution of the E. M. F.'s is given in the diagram. In my judgment, this type of motor will be of great practical use; not only will these motors successfully handle all constant load problems, such as pumping, blowing, etc., but they will be exceedingly useful in crane and elevator work, while their service in propelling cars can hardly be estimated. In all cases where hand control is required, they can be operated as successfully as continuous current motors.

The most serious question we have met in pursuing this problem has been that of finding a suitable condenser. It may be well to state that none of the ordinary types of condensers, viz., those made of paper, paraffine, glass, mica, etc., are of the slightest use. We have found that the residual charge in all the above-mentioned substances absolutely prevents their acceptance; this residual charge seems to depend upon the non-homogeneity of the dielectric and upon the want of an absolute contact between the plates of the condenser and the dielectric surface. When glass is used as a dielectric and a potential of 1,000 volts (average) is maintained upon the condenser, the glass heats rapidly until, finally, it is shattered to pieces. Condensers of glass, when raised to a potential of 15,000 volts, became phosphorescent, rapid flashes of light appeared in various parts of the glass, while they withstood the potential, which was only for a few moments. Vulcanite we find unreliable; metallic chips are always present and for this reason, if for no other, it fails to stand satisfactorily. We have succeeded in producing what we call "films" from .003 to .005 of an inch thick, which will surely stand a potential of 1,000 volts. We believe that these condensers are entirely commercial, that they will not deteriorate, while their cost per microfarad is quite low. So perfect are they, that they show but little trace of residual charge, they do not heat perceptibly when in circuit for a long time, and withstand a potential of from 2,000 to 3,000 volts with a dielectric thickness of .006 inch. The processes of their manufacture will not be made public at present.

Mr. Kelly and I have produced motors which are operative on existing circuits. As we have stated, our motors start at full torque, run to a definite speed and behave exactly like direct current motors under load. So perfectly does our compensating winding eliminate the E. M. F. of self-induction from the armature circuit, that this circuit offers very nearly the same opposition to alternate currents of a frequency of 130 ~ p. s. that it offers to continuous currents; there is, therefore, little falling off of speed due to the self-induction of the armature circuit; in fact, we can over compound the motor by its own load by setting the brushes off the neutral point of commutation, thus changing the flux through the field.

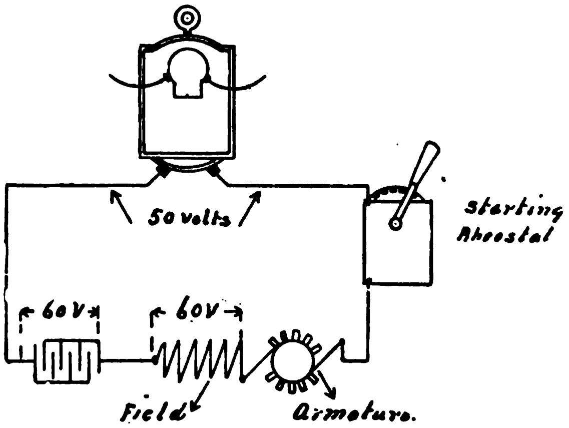

FIG. 4.

I feel convinced that the coming year will place the alternate current motor firmly on its feet, and that before the year elapses many stations represented in this convention will be testing the accuracy of the statements contained in this paper.

UNDERGROUND CONSTRUCTION OF THE BUFFALO RAILWAY CO.[1]

BY J. B. CRAVEN.

UNDERGROUND construction for railroad use brings us many problems to solve. Whilst not using a high tension current, we have one side of our system always grounded, so that between the many miles of cables in use and the earth we have a difference of 500 volts; thus you see at once the necessity of having and keeping up the highest insulation possible. This question of ground return requires that the insulation resistance of a railway circuit be twice that of an arc or incandescent underground system, where you have a metallic circuit; then there are the constant and excessive strains that one does not meet either in arc or incandescent lighting, due to the throwing off and on of the cars. It is almost impossible to figure your feeders to carry the maximum current, so that at any time you are liable to have your cables over-loaded, bringing very heavy strains upon them.

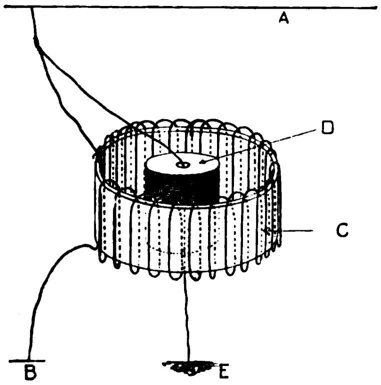

FIG. 1.

Another question is the one of connecting overhead with underground wires. This brings lightning to the field to be guarded against, for the large surface of trolley wire offers an attractive path for lightning, and how to protect the underground feeders and mains has been quite a problem. Lightning has little regard for insulation, seeming to want a path only to earth; this path is offered by the underground cables, so that we have to introduce some arrester at the junction of the underground and overhead wires to give it some other path.

Fig. 1 shows by what means we hope to accomplish this end. A is the overhead conductor, B is the underground cable to be protected, D is a non-inductive path to the ground, C is a coil with an iron core grounded through a fuse. This, you see, will offer two paths to the lightning; one of very low resistance to the dynamo current, but very high resistance to a lightning discharge, due to its self-induction; the other a very high resistance to the dynamo current, but a very low resistance to the lightning discharge.

This arrester is placed inside a water-tight iron box on top of a pole, wherever a tap is made with overhead wires; this box also affords a good place where overhead and underground wires can be connected and keep moisture from the cables; this is accomplished by wiping a three-inch lead cup onto the lead of the cable and filling it with insulating compound.

We have in this city about 11⅛ miles of subways, divided into two trunk lines, which branch off, carrying feeders to the outlying districts. Our conduits are laid in cement, 30 inches below the surface of the street. They are crowned in the center, so that the water will drain to the manholes, which in turn drain to the city sewers, with a bell-trap to prevent sewer gas coming back. Lately, on account of natural gas finding its way into subway and manholes, we have found it necessary to attach a blower at the station, which ventilates the whole system. Manholes we have placed every 400 feet, and have tried to make that distance standard, as pulling a greater distance brings an excessive strain on the cable when drawn in.

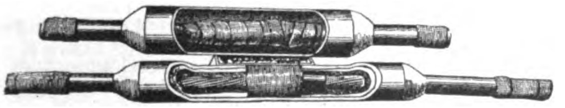

FIG. 2.

After careful consideration before this work was started, we decided to depend on our cable for insulation, not on conduits made of insulating material. To me it seems impossible to prevent moisture from penetrating the latter system, thereby lowering the insulation. We depend on our ducts for mechanical protection alone. The cables in use here are lead-covered, provided with an exterior fibrous jacket or covering saturated with pitch, the purpose of which is to protect the cables whilst being drawn in the duct. We have some 45 miles of cables, which have been in use since July last. These are of two classes—one for insulation depends on pure Para rubber, the other on a composition, our shortest feeder being two and a half miles in length, some of the longer ones reaching a distance of eight miles; yet the insulation on none at the present day is below 120 megohms, the short ones testing as high as 1,100 megohms. In laying this cable all tests were made in the testing-room at the station; this was made feasible by the use of a telephone circuit throughout the underground system, so that a workman making a joint in a manhole was in communication with the man making the the test and could always find out if his work was satisfactory. The joints made were the standard joints used by the companies from whom the cable was bought. A view of these will be seen in Fig. 2, the lower one being the one used for the rubber covered cable, showing the consecutive layers of insulating tape; the first, which is next to the copper, being a narrow white tape, free from sulphur; then follows a layer of pure Para rubber tape; upon this is wrapped a layer of rubber compound, then a layer of black rubber, and around the whole is wound cloth tape of a sufficient thickness to entirely fill the lead sleeve; the ends of the lead sleeve are then dressed down and wiped to the lead covering of the cable with an ordinary plumber's wiped joint.

The upper view represents a joint as made in the cable, using composition for insulation; the method here employed differed from the foregoing in that the lead sleeve is slipped over the completed copper joint, dressed down and wiped, the sleeve then being filled with compound through two small holes tapped through the top which are afterwards closed permanently with a soldering iron; each feeder, for the purpose of tapping off branches to feed the trolley wire and to facilitate the breaking of cables in case of trouble, is run through a junction box, Fig. 3, every 1,000 feet. The box shown in the cut has eight stubs, which allows three cables to pass through and be broken, and two taps to be taken off for feeding purposes.

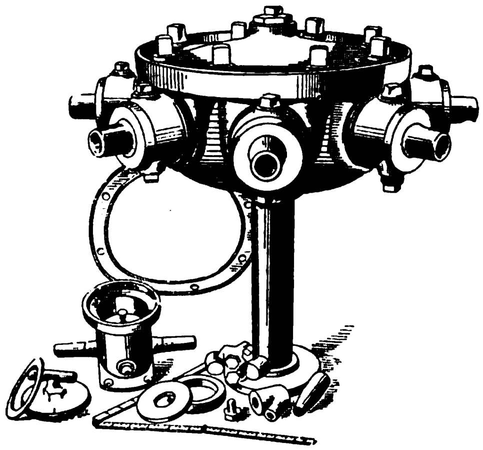

FIG. 3.

A small telephone box is seen at the left. One of these is placed in each manhole, the terminals of which are all in multiple.

A few words in regard to the testing of this system and the difficulties encountered on account of one side being grounded. We are obliged to test at night, when the load can be thrown off one feeder and onto another; then it is disconnected by means of a switch where it connects to the overhead, and the test is then made. It is rather a slow process, but the only one left open to us. The testing-room is equipped with first-class instruments for practical use. The galvanometer, which is of the Thomson reflecting type, is enclosed within a magnetic shield made of wrought-iron pipe, and also suspended by three springs to absorb vibration. The rest of the instruments consist of a chloride of silver battery, standard resistance and shunt and reversing key. It also includes a telephone communicating with the manholes.

Thus far we have looked upon the difficulties and disadvantage of the underground system. No arguments have been advanced in its favor, but I think you will agree with me that it has some. First, it does away with the public objection of disfiguring the streets, obstructing firemen in their duties, and, in the case of high tension currents, a menace to life itself; and then the liability of wires falling, causing a suspension of traffic, and, in case of a storm, causing a delay and loss of thousands of dollars to the companies themselves.

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[1] Abstract of a paper read before the National Electric Light Association, at Buffalo, Feb. 23, 1892.

THE RELATION OF SIZE AND EFFICIENCY IN TRANSFORMERS.[1]

BY L. B. STILLWELL.

THE designer of a transformer has presented to him alternative paths. He may easily design with reference to a very small loss of energy and relatively high efficiency at light loads, if he is willing to sacrifice regulation. He may design a transformer of little weight and large output, if he is content to work at a very high temperature, which may, perhaps, endanger the lasting qualities of his insulation. The best transformer is not necessarily that which has the lowest leakage or magnetizing current; nor that which regulates most closely; nor that which is lightest and most easily handled; nor yet that which will carry its full load indefinitely with the least increase of temperature; but it is that transformer which best combines as much of each of these desirable properties as is practicable. In comparing various types, therefore, it is necessary to begin with a realizing sense of the fact that the same laws govern all types as to design and performance; and that, under the general laws of physics which have to do with this class of work, extraordinary excellence in one respect is necessarily obtained at the price of sacrificing excellence with respect to other properties equally important.

I propose, without venturing further upon the domain of theory than is absolutely necessary, to glance at what may be called the geometrical relations of transformers of various sizes, and so invite the attention of owners and operators of central station plants to a subject of very considerable practical importance to them.

It is safe to say that a commercial transformer, by which I mean a transformer that can be manufactured at a cost that will make it a commercial or saleable article, cannot be so designed so as to have a loss of less than 20 watts, due to the magnetization of the iron. A transformer twice as large—that is, of 10 lights capacity—is called upon to do precisely the same work and no more in developing counter E. M. F. to oppose that of the dynamo and may quite as easily be designed to work with an iron loss of 25 watts. If the rated capacity of the five-light transformer is 250 watts and of the 10-light transformer 500 watts, the loss in the former will be 8 per cent. and in the latter 5 per cent. A 20-light transformer may as easily be designed to work with an iron loss of 30 watts, and a 40-light transformer with an iron loss of 45 watts; the percentage of loss in these cases being, respectively, 3 per cent. and 2.25 per cent.

One ten-light substituted for two five-light transformers will reduce the amount of energy lost in magnetizing the iron from 8 per cent. to 5 per cent., a saving of 3 per cent. One 40-light substituted for two 20-light transformers will reduce iron loss from 3 per cent. to 2.5 per cent., a saving of one-half of 1 per cent. About the same percentage of saving can be effected by again doubling the size, and 100-light transformers can be furnished in which the iron loss does not exceed 1.7 per cent. Beyond this figure it is easily seen that improvement is difficult and even were it possible, by employing a very large transformer, say, one of 500 lights capacity, to reduce iron loss to 1 per cent., the improvement in efficiency resulting from the substitution of one of this size for five of the 100-light size would be but a fraction of 1 per cent., and, in view of the necessarily greater weight and the obvious objections to putting a large number of eggs in one basket, the advisability of such substitution would be doubtful.

Thus far we have considered only the loss in iron when no current flows in the secondary circuit, and it will be sufficiently accurate for our purpose to assume that this iron loss remains constant under varying loads of the transformer. The loss of energy due to the resistance of the copper when no current flows in the secondary is negligible, since the magnetizing current in the primary is very small, but this load increases as the load on the transformer is increased, and the increase varies as the square of the current flowing; that is to say, the copper loss is four times as great when two amperes flow in the secondary circuit as when one ampere flows in that circuit. In the transformer without load we have a certain loss of energy designated iron loss, while in the transformer fully loaded we have this same iron loss plus the maximum copper loss. For intermediate loads we have, approximately, the same iron loss with varying copper losses dependent upon the amount of the load.

The loss due to the resistance of copper is generally about 2 per cent. This does not vary materially with a variation in size of the transformer, certain considerations having to do with regulation being largely accountable for this fact. If we assume that the loss in copper at full load for every size is 2 per cent., and that the iron loss is constant, irrespective of the load, the following table will, with sufficient accuracy, indicate iron and copper losses and efficiencies at full load. The table does not represent actual measurements of selected transformers, but is intended to fairly represent the proportionality of losses in transformers of various sizes. Actual tests will show results as good as, or even better than, the figures given in the table.

Capacity in 16 c. p. lamps.	Loss in iron.	Loss in copper.	Efficiency at full load.
5	8 per cent.	2 per cent.	90 per cent.
10	5 "	2 "	93 "
20	3 "	2 "	95 "
30	2.5 "	2 "	95.5 "
40	2.3 "	2 "	95.7 "
60	2.1 "	2 "	95.9 "
80	1.9 "	2 "	96.1 "
100	1.7 "	2 "	96.3 "
300	1.5 "	2 "	96.5 "

It will be seen that for sizes of less than 20 lights capacity the falling off in efficiency as we go down the scale of sizes is very rapid, while, on the other hand, the gain in efficiency of transformers larger than that of 20 lights capacity is much less marked. The exact significance of the table will, perhaps, be better shown by putting it in another form. Let us compare the losses at no load and at full load in 1,200 lights capacity of converters of each of the several sizes, and let us express the loss in each case in terms of the number of 16 c. p. lamps, which the energy so lost would be sufficient to supply. We then have the following:

Transformers used.			Loss at no load.	Loss at full load.
240	5-light	capacity.	96 lamps.	120 lamps.
120	10	"	60 "	80 "
60	20	"	36 "	60 "
40	30	"	30 "	54 "
30	40	"	$27\frac{6}{10}$ "	$51\frac{6}{10}$ "
20	60	"	$25\frac{2}{10}$ "	$49\frac{2}{10}$ "
15	80	"	$22\frac{8}{10}$ "	$46\frac{8}{10}$ "
12	100	"	$20\frac{4}{10}$ "	$44\frac{4}{10}$ "
4	300	"	18 "	42 "

These figures plainly show that to supply any number of lamps up to 100 it is desirable, on the score of efficiency, to use a single transformer of the required size rather than two or more of less capacity.

For sizes of a capacity above 100 lights the improvement in efficiency is necessarily little, and although the argument on the score of efficiency is still in favor of the use of the large sizes, that argument is by no means as strong as it was before we passed the 100 light limit.

In favor of the use of large sizes is the very practical argument of reduced cost per lamp capacity. In giving proper weight to this consideration the purchaser should assure himself that the manufacturer has not effected a reduction in cost at the price of an excessively high limiting temperature, which may endanger the lasting qualities of the insulation.

Transformers of 300 or 500 lights capacity are naturally large and difficult to handle; or if they are not very large it will be well to again note the temperature.

An investment in a 500-light transformer is large as compared with an investment in one of 100 lights capacity, and the chances of accident, such as may be caused by lightning, are quite as great in the case of the former as in the case of the latter.

It is extremely improbable that a static discharge from the line caused by lightning will damage more than one of a group five transformers which may be connected together in multiple arc, while a discharge which may break down the insulation of one of these will be quite as likely to damage a 500-light transformer.

THE ALLIED POWERS.[1]

BY D. ASHWORTH.

AFTER a few words of introduction, in which the forces of steam and electricity were compared with the Allied Powers of Europe, the speaker continued:

This subtle and all-powerful agent, electricity, this reinforcement and seemingly inseparable hand-maiden of the older agent, steam, will be left for those whose lines of thought and action have been concentrated thereon; those among you who have been and are continually developing its hitherto unknown resources and powers; to you is relegated the pleasant duty of presenting its claims to an enlightened and appreciative public while we present to them the older one, that of steam and the steam engine.

There is a very notable feature in the development of the steam engine, as relates to James Watt, to which I invite your attention, and that is, that all the principal features so essential to economy of fuel, regulations and benefits to be obtained by expansion were fully considered by him. He was fully cognizant of the insidious losses by condensation, so that, after all, the marvelous progress that has been made in this direction has been in the refining of well-known existing conditions rather than the profundity of philosophical though tbestowed uponit by Watt in its early stages. The gradual perfection of mechanical appliances in the form of tools, etc., again contributed to the still greater success, until at length it seemed that the acme of excellence had been attained in workmanship.

It is not our purpose to enter upon any description of the many devices which ingenious and fertile minds developed during these periods, but it is generally acknowledged that the drop cut-off valve, invented by George Sickles, embracing as it does the tripper and dash-pot, giving an instantaneous cut-off, gave the keynote for further and more thorough steps in this direction. This was followed by the Corliss system of valve motions, producing results which attracted the attention of not only the engineering world, but the vast body of steam consumers.

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[1] Abstract of a paper read before the National Electric Light Association, at Buffalo, Feb. 23, 1892.

[1] Abstract of a paper read at the Buffalo meeting of the National Electric Light Association, February 24, 1892.

We now reach a point that may be worthy of attention—at all events, may lead to an idea; since the advent of electric lights and motors the refinements of the steam engine in every respect to meet the requirements have more than surpassed those of the half century preceding.

It may be said, without exaggeration, that during this period the finest intellects have been taxed to their utmost in research of principles to meet the exacting demands of the electrical requirements.

In the matter of steam or fuel economy, a general survey of the field in this direction reveals results of a marvelous character. Looking back to the period antedating the advent of the electric power, the majority of cases were well content with a result of four or five pounds of coal per horse-power per hour. With the advance in the adoption of the compound system, one and a half and two pounds are attained in practice.

As has already been stated, the results in regulation and economy in engine practice to-day would seem to fill the round of desires or expectations at least. There yet remains much to be done in the direction of design with a view to durability, embracing within itself those qualities which, in a machine of continuous operation, would reduce the wear and tear to a minimum or scarcely appreciable amount.

In the matter of economy in the adoption of early points of cut-off and rates of expansion, it has been conceded that the positions of pure theorists, governed by the laws of thermodynamics, when brought into the actual school of practice and measured by the searching light of commercial conditions, were at variance. A halt upon this important point was the result, and now these theories are rapidly being modified and brought into close relation with accurate and first-class practice.

The numerous types and systems of steam generators brought to our notice constantly give ample testimony to the continued interest manifested in this important direction. Strength to resist pressure, durability, facility of access to clean and repair, are imperative. For economic results an abundance of steam capacity is requisite to produce the quantity of steam and, what is of equal importance, quality of same. The latter is receiving close attention, indeed, so much as to receive favorable commendations from our compeers abroad.

We are prepared to hear it said that these are but common truisms and are like twice told tales. We know it, but at the same time, they are such as will bear repetition. No attempt is made to describe any of the marvelous points of mechanism or to demonstrate with mathematical precision the unerring laws which, when formulated, reveal the very foundations of the principles by which these mighty results are achieved, the object being simply to point out the various causes of friction frequently introduced between these two powers like unto the welding heated surface to join, foreign particles prevent a perfect union, our desire being a cementing together, an harmonious working.

THE TRANSMISSION OF ELECTRIC ENERGY BY ALTERNATING CURRENTS AND ITS UTILIZATION BY CONTINUOUS CURRENTS.[1]

BY H. WARD LEONARD.

After a few introductory remarks in regard to the relative merits of continuous and alternating systems for the transmission of energy, the speaker continued;

The high tension alternating current says:

"How easy it would be to get there if somebody could only utilize me." And the low tension continuous current says: "How easy it would be to use me for any application if somebody could only get me there."

I stand here to make the claim that the transmission of power over great distances necessitates the use of both the alternating and continuous currents, and that by the combined use of the systems the result is commercial to-day over any reasonable distance, and for the transmission of any amount of power.

I arrive at this conclusion, as follows: The economical use of electric energy with automatic control of the speed and torque demands that the voltage be varied as the speed, and the current as the torque. It will be evident that for merely transmitting electric energy from a prime motive power of constant speed there can be nothing simpler or better than the synchronous alternating current motor of constant potential. But nearly every application of the transmitted power demands not only a variable torque, but a variable speed, as will be evident when we consider hoists, locomotives, pumps, ventilating fans, etc. The synchronous character of the alternating current is therefore unsuited to such work.

It would seem, therefore, that both theoretical and practical considerations demand that we should transmit our energy over the great distances demanded for commercial applications by means of the alternating current, and that we should then convert it into a continuous current in order to best utilize it. Under this plan we shall be able to undertake the transmission of power at any distance and on any scale by apparatus manufactured by half-a-dozen companies to-day.

Let us suppose, for example, that we have a water-power at a distance of twenty miles from a mine where it is desired to utilize 2,000 h. p. for various purposes.

Let us start with 10,000 volts and lose 22 per cent. in the conductor. The cost of our generator, conductor and synchronous motor will be about $90 per horse power at the point of work The synchronous motor will drive the necessary continuous current generators of 500 volts and less to supply hoists, pumps, locomotives, ventilating fans, air compressors, incandescent lights, arc lights, crushers, mills, etc. If the total power installed be 2,000 h. p. the cost of the working motors will be $50,000. With 2,000 h. p. installed, the maximum demand for power will not exceed 1,500 h. p. The cost of continuous current generators and conductors for this service will be about $52,500, and the cost of the synchronous transmission system about $135,000. Allowing $42,500 as an average cost for the development of the water-power and the construction, we have a total cost of plant of $280,000 or $140 per horse power represented in the electric motors at the point of work.

The starting up of the synchronous alternating current motor without load can be readily accomplished by any one of several simple methods, such as the use of a small storage battery supplying current to one of the continuous current dynamos and operating it as a motor to drive the alternator up to synchronism, or the utilization of the energy of a weight upon a hoist in its descent to operate its motor as a generator which in turn will drive the continuous current generator as a motor and thus bring the alternator up to its synchronous speed.

It seems to me that we should install a plant at the mine exactly as though we were going to drive it by a steam engine, and, instead of doing so, use the synchronous alternating current motor for this purpose, and utilize as our original source of power the distant water-power. In many instances, this method will be of especial value where it may be necessary for a few weeks in a year to fall back upon expensive steam power on account of the temporary failure of a distant cheap water-power.

If one comprehensive plant be installed of this alternating and continuous current type, I believe an enormous development in this line will immediately follow, and luckily the apparatus required can be turned out rapidly from any one of several large works without the delays incidental to the development of new apparatus and methods.

THE OPERATION OF HIGH-TENSION CURRENTS UNDERGROUND FROM A PHYSICAL AND FINANCIAL STANDPOINT.[1]

BY E. A. LESLIE.

In presenting this paper, I shall endeavor to confine myself strictly to my own experience and observation, submitting only such data as I may have been personally able to collect, and leaving it to you to decide whether, it having been determined that the successful operation of high-tension currents underground is physically possible, the financial aspects of the case will permit its general introduction.

CONDUITS.

The underground conduits in New York City for high-tension currents are owned by the Consolidated Telegraph and Electrical Subway Company, who lease their ducts to the various electric lighting companies.

The prevailing type of duct is of iron pipe, mostly three inches in diameter, running along the sides of the streets into manholes about 275 feet apart. These are the so-called "trunk ducts." Over the trunk ducts are superimposed from two to four distributing ducts, with four-way handholes about 50 feet apart. Many of these handholes are brought to the surface of the street and are covered over with an iron plate, which is easily removable, giving ready access to the wires in the distributing ducts. In many places, however, the handholes do not approach the surface, and, in order to get at the wires to make changes or connections, it is necessary to dig up the street. Again, on some of the prominent streets no distributing facilities whatsoever have been provided and the companies are compelled to make long and expensive house connections from manholes. This is particularly true of Sixth avenue above Eighteenth street and Broadway above Thirty-fourth street.

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[1] Abstract of a paper read at the Buffalo Convention of the National Electric Light Association, Feb. 24, 1892.

[1] Abstract of a paper read before the National Electric Light Association, Buffalo, Feb. 25, 1892.

The Subway Company have also a number of miles of a system which is made up of sectional iron castings and so framed together as to combine in one conduit both trunk and distributing facilities. These conduits have no surface handholes and, in order to make changes or connections, it is also necessary to dig up the street. The manholes are about 275 feet apart as in the case of the iron pipe. There is also a small amount of conduit in use, which is composed simply of cement-lined iron pipes, running from manhole to manhole, of about three inches inside diameter.

The cost of the New York conduits is an unknown quantity. The Subway Company guard the secret well, and, beyond the general statement that they have cost, on an average, nearly $5,000 per mile, per duct, no reliable information can be gained. In these figures, however, are doubtless included the expenses of years of legislation and long and costly litigation. It is the universal opinion among electric light men in the city that the actual average cost should have been less than $3,000 per mile of duct.

CABLES.

The companies with which I am connected use, principally, cables insulated with a rubber compound, although we also have in use 35 or 40 miles of cable, the insulating material of which is fibrous. Perhaps the best description of cables I can give is to embody herewith a copy of our specifications, which, with slight modification, are in general use by the New York companies.

SPECIFICATIONS FOR UNDERGROUND CABLE.

Wire.—No. ——— B. & S. (solid or stranded) must contain no joints or splices.

Lead Covering.—To have an alloy of from four to five per cent. tin. Thickness of lead, $\frac{3}{32}$.

Insulation.—Outside diameter, ——— 32ds (usually $\frac{5}{32}$ to $\frac{7}{32}$ all around the conductor). Resistance of insulation without lead covering, after at least 48 hours' soaking at temperature of 75 degrees Fahrenheit, 1,500 megohms per mile. Resistance dry test with lead cover and without lamp connections, 1,500 megohms. Resistance of insulation after three years' use to be up to the standard required by the Board of Electrical Control, which is not less than five megohms per mile, per 100 volts of current employed up to, for example, 3,000 volts, *i. e.*, 150 megohms.

Copper.—Conductivity of copper, 98 per cent. To be medium hardness; that is to say, a mean between hard drawn and soft copper.

Diameter.—Outside diameter of cable, including lead covering ——— 32ds (depending upon the size of the wire).

Electrical tests of insulation to be made at factory by company's representative. If insulation is taped, outside diameter of cable to be ——— 32ds.

Capacity.—Cable shall be capable of carrying an alternating current of ——— volts and ——— amperes; or continuous current, ——— volts and ——— amperes.

Laying and Connecting.—The cable to be laid and connected by the ——— Electric Light Company under the supervision of the manufacturers, who shall carefully supervise the work, and, after accepting the same, shall be liable under the guarantee in the same manner, and to the same extent, as if they (the manufacturers) had themselves laid and connected the cable.

It is usual for manufacturers to guarantee their cables for a term of three years, and a special form is provided therefor.

The cost of lead-covered cables, such as the above specifications call for, varies considerably according to the size and manufacture. Roughly speaking, however, No. 4 cable ranges from 15 to 20 cents per foot, or, from $792 to $1,056 per mile. No. 2, from 25 to 30 cents per foot, or, from $1,320 to $1,584 per mile. No. 00, from 37½ to 45 cents per foot, or, from $1,980 to $2,376 per mile. No. 0000, from 55 to 65 cents per foot, or, from $2,904 to $3,432 per mile. In other words, underground conductors cost from four to five times as much as overhead conductors, which is a matter to be carefully borne in mind.

LAYING.

The manner of laying cables is simple. It is first necessary to draw a rope through the duct to be occupied. To do this, rods about three feet in length are used, having brass male and female screw attachments, one at each end. The first rod is inserted in one end of the duct; then another is screwed into it and pushed forward, and this process is continued until the first rod emerges into the manhole at the other end and you have an unbroken line of connecting rods through the duct. A rope is then attached to the last rod, and, as the rods are pulled forward and unscrewed in the manhole at the distant end, the rope is gradually drawn through. Unless a large number are to be drawn into a single duct, they can be drawn by hand without any special machinery. If, however, it is desirable to draw in as many at one time as the duct will hold, it is necessary to use a winch or windlass, or, in lieu of either, a snatchblock with a rope and tackle, and enough men to pull the mass. Great care should be observed not to allow the cables to twist in the duct, as, if this occurs, it is next to impossible to withdraw any given conductor thereafter without removing all conductors in the duct. In cutting the cables to fit given sections, about 12 feet should be allowed for slack between manholes, for racking around the sides of manholes and for metallic joints. The cost varies considerably. To draw in two cables in a duct would cost in the neighborhood of from 2½ to 3 cents per foot of cable; but to draw in four or six, or even eight, as has frequently been done, the cost diminishes and will not average over two cents per foot, or even less, assuming that the men in charge have had experience and understand their work thoroughly.

JOINTING.

The proper jointing of cables is a matter of paramount importance. Unless the joints are made by an experienced person, it is almost impossible to secure a joint which will give the same insulation resistance as the cable itself, and yet, unless the joints are so made, the object of securing immensely high insulation in the cables proper is entirely defeated and a large proportion of the original investment practically wasted.

The New York Subway Company, in its early inception, framed a set of rules governing the operation of underground conduits. Among them is one which has always challenged my admiration and the man who framed it either built wiser than he knew, or was a remarkably gifted person. This rule at first was considered absurd and impossible of compliance, but to-day I think I am safe in saying that every electric light company governed by it will acknowledge its wisdom and admit that, by having enforced a high standard of insulation from the very outset, a large amount of subsequent experiment and waste of money has been avoided. I quote the rule:

> *Section* 4, *Electromotive Force.*—"All conductors drawn into and operated in the conduits, and intended to convey currents of an electromotive force exceeding 100 volts, shall have at the temperature of 75 degrees Fahrenheit, an initial insulation resistance of not less then 15 megohms per mile per 100 volts electromotive force of current in the circuit. Whenever the insulation resistance of a conductor as aforesaid shall prove to be less than five megohms, per mile, per 100 volts, the use of that conductor shall at once cease, unless the actual electromotive force in its circuit be reduced so as to re-establish the foregoing ratio."

You will observe that the initial tests of cables laid by any of the companies in New York city must show an initial insulation resistance of not less than 15 megohms per mile, per 100 volts of current used. This means that, with an alternating current of 1,000 volts, the cable must show, before the current is turned into it, an insulation resistance of not less than 150 megohms per mile; with an arc circuit of 2,500 or 3,000 volts, or even 4,000 volts, initial insulation resistance must not be less than 375 megohms, 450 megohms and 600 megohms, respectively. Taken into consideration with the fact that on an ordinarily humid day, overhead circuits will not show an insulation resistance of more than from 200,000 to 500,000 ohms per mile, the above requirements seem altogether impossible of attainment and to be ideal rather than practical, but this is not the case. On the contrary, it is rare, indeed, that the initial tests of cables laid in New York city, do not show from three to four times the initial insulation resistance required by the rule, and, of the hundreds of miles of cable actually in operation at the present time, and which have been in operation from two to three years, and with which I am personally familiar, I do not believe that there is one that will not show, under like conditions, nearly, if not quite, the same high degree of insulation, as when the original test was made. In fact, I have proved this to be true many times, and will cite one of our latest tests.

Initial Test, November 17, 1889.—Weather, clear; temperature, 60 degrees Fahrenheit; constant, 33,000. Leg No. 1: Length, .95 mile; deflection of galvanometer, 25 divisions; total insulation resistance, 1,320 megohms; insulation resistance per mile, 1,259 megohms. Leg No. 2: Length, .95 mile; deflection of galvanometer, 20 divisions; total insulation resistance, 1,650 megohms; insulation resistance per mile, 1,567 megohms.

Last Test, February 5, 1892.—Weather, fine; temperature, 25 degrees Fahrenheit; constant, 33,000. Leg No. 1: Length, .9 miles; deflection of galvanometer, 12 divisions; total insulation resistance, 2750 megohms; insulation resistance per mile, 2,475 megohms. Leg No. 2: Length, .9 mile; deflection of galvanometer, 10 divisions; total insulation resistance, 3,300 megohms; insulation resistance per mile, 2,970 megohms.

It is, of course, apparent that the conditions under which this last test was made were much more favorable than in the case of the initial test, but I think it is also apparant that the insulation resistance of the cable has suffered little or no deterioration after more than two years of constant use.

This would be impossible with poorly insulated joints. The first cable laid by the Manhattan Electric Light Company on Broadway was insulated with rubber compound and the joints were made by contract, on the representation of the contractor that his men were professional jointers. After the cable was connected throughout, a test showed less than a megohm of insulation per mile, and this bad condition of things was quickly shown to be in the joints; every one of them had to be cut out and our lesson was well learned. Since that time we have never allowed any but our own men, specially trained and educated for the purpose, to make joints on rubber compound cables. The cost of joints will run from $2 to $3 apiece and any manufacturer can give proper directions how to make them and what to use, both as to metallic contact and insulation; but, in the case of the rubber compound cables, the difficulty lies more with the man than with the method. Men whose hands are naturally moist cannot make a good joint, *i. e.*, a joint which will test "infinity."

TESTING.

We are required to test all underground circuits at least once per week. For this purpose a portable reflecting galvanometer is used. Where the cables enter the station a test-room, free from the jar of the building, is usually provided in which to set up the instruments; but, in cases where the cables are reached from the station by overhead wires, it is customary to rent a quiet room adjacent to the junction-pole and connect by a well-insulated "lead" for permanent use. The total insulation of a circuit with all converters or arc lamps connected, will generally fall below the requirements of the rule above quoted, but, unless it is shown to be less than say one megohm per mile of cable, its condition, as a "completely connected circuit," is usually accepted. But, as a general rule, when the insulation falls below this standard, what are termed "ex-converter" and "ex-lamp" tests are called for. These require, in the case of incandescent circuits, that every converter installation be cut out, the cable ends freed from all contact, and test of cables only be made to ascertain their exact condition. The arc circuits are similiarly treated by disconnecting all lamps and switches. Unless the results of such tests come within the limit prescribed by the rule, the circuits are not allowed to be operated until the defect has been removed and the insulation brought back to the required standard. Fortunately, defects are rare, and tests of this character are not now called for with sufficient frequency to prove burdensome.

HOUSE CONNECTIONS.

House connections are built by the Subway Company at the expense of the electric light companies; but the Subway Company claims not to relinquish ownership therein, and will not allow their joint use by two or more companies, except by special arrangement. The cost of house connections in New York City is appalling to the man of exclusively overhead experience. I will quote a few selected at random:

On upper Sixth avenue:

To No.	House Pipe.	Cable and Labor.	Total.
888 Sixth avenue............	$108.57	$59.93	$168.50
527 "	141.96	79.06	221.02
1011 "	78.51	54.10	132.61
846 "	155.08	88.56	243.64

Many of the streets have subways upon one side only. House connections from handhole boxes to the opposite side of the street are long and expensive, for instance:

To No.	House Pipe.	Cable and Labor.	Total.
1860 Third avenue............	$124.67	$43.60	$168.27
1995 "	124.59	50.60	175.19
2401 "	118.54	61.66	180.20
1666 "	153.65	47.60	201.25

Distribution to side of street on which conduit is laid, or where there are distributing facilities on both sides of the street:

To No.	House Pipe.	Cable and Labor.	Total.
1924 Third avenue............	$24.82	$25.42	$50.24
2102 "	24.54	16.00	40.54
666 Eighth avenue...........	31.03	22.47	53.50
728 "	21.84	23.84	45.68

The cost of connections to city lamp posts, including pipe, cable and labor, averages about $110 per post.

You will observe that, in some cases, the cost of these connections exceeds the gross revenue derived from an arc lamp for an entire year, but, unless we resolve not to develop the particular territory in which these cases occur, we are obliged to invest our money and take chances for the future.

Fortunately, it often happens that one house connection will serve for two or three different installations, and, in this way, the average cost per installation or per arc lamp, is very largely reduced. For instance: In the fall of 1890 our arc lamp connections cost us, on an average, only $43; in the spring of 1891, an average of about $30; the ratio of new connections to new installations or lamps being as one is to two. In other words, for 100 installations or lamps we were required to make but 50 house connections. This ratio could be largely and safely reduced were we allowed by the authorities to use more than 100 feet of overhead wire with each underground connection.

SOME FEATURES OF UNDERGROUND OPERATION.

It is a fact worth knowing that the underground service is more reliable than that of the overhead. Storms, blizzards, sleet and wet snow have little or no effect upon it, and neither has lightning, where the circuits are entirely underground. In consequence, cases of interruption are rare; crosses never occur; grounds but seldom, and open circuits are unknown, except when a break occurs at a lamp or a switch. The number of "burn-outs" in the subways is small, and thus far, after three years' experience, not a single instance of burn-out has occurred in our "rubber" compound cables that has not been directly attributable to some imperfection of manufacture, which originally escaped detection, or to mechanical injury after the cables were laid. And these have not amounted to more than 10 or 12 all told. We have, however, had several instances with the "fibrous" compound, but whether due to accidental abrasion of the lead covering, which is fatal to that form of insulation, or to some inherent defect, we were unable to determine, as the intense heat of the escaping current destroyed all evidence in each case.

On wet nights we have an occasional case of trouble in a leaky switch-box, or, at an exposed joint, where the wire running to the lamp is connected with the cable. These joints were at first covered with ordinary tape, but after a few months' exposure the tape would invariably leak under the high pressure and sometimes convey the current to the lead covering and result in a burn-out. In the case of rubber compound cables, we now simply cut back the lead a few inches, strip off the taping, make an ordinary metallic joint and then slide over the bare metal a floor insulator, open at both ends, and standing upright so as to allow the rain to run through the lower end; the insulator resting upon the rubber compound, not upon the lead covering of the cable. This, of course, refers only to lamps where switch-boxes cannot be used, such, for instance, as city lamps. Where fibrous cables are used, a regular insulating joint of pure rubber is made, connecting to a short piece of specially insulated wire. The joint is immersed in boiling hot paraffine and the specially insulated wire is then connected in the ordinary way to the wire running to the lamp. This is done to protect the insulation of the cable from moisture and also to facilitate connecting and disconnecting with the lamp, which the regulation tests frequently render necessary.

In laying cables it has been found desirable to place both "legs" of incandescent circuits in the same duct. When they are separated into different ducts great loss results from self-induction.

The use of the subways makes it possible to employ much heavier single conductors than could be used overhead. There are in some of the ducts conductors having nearly, if not quite, 500,000 circular mils area, and such sizes as No. 00 and No. 0000 are quite common. The conductor being composed of small wires stranded, affords sufficient flexibilty for all purposes; but in sizes up to and including No. 2 B. and S., the conductor is generally solid.

In the matter of public safety, the records of the past three years show but one death to have occurred from the current conducted underground, and that particular case occurred on top of a city lamp-post on a wet night, the victim neglecting to use his gloves.

The arrangement of the underground system is exceedingly cumbersome; that is to say, it requires much greater time, as compared with overhead methods, in the construction both of trunk lines and house connections. Under the old overhead system an order for an arc lamp, for instance, could be executed within two or three hours after its receipt and the whole cost of hanging was not to exceed anywhere from $8 to $12; now, however, in order to hang an arc lamp and connect therewith, it is necessary to make formal application to the Subway Company for the house connection, and this requires, on their part, anywhere from three to ten days' time. After receiving due notice that the house connection has been built, we are then required to apply to the Board of Electrical Control for a permit to hang the lamp and connect it with the underground conductors. This requires additional time, amounting to from three to ten days, often two weeks and even longer; and, in a number of instances, before we were finally permitted to fill the order, the prospective customer had become disgusted with the delay and canceled his contract. The Subway Company have also to apply to the Department of Public Works for a permit to open the street and must receive the same before they can proceed with the work, making in all three distinct applications to three different bodies for each house connection. Again, the underground system rigidly circumscribes the territory in which current can be distributed to the streets through which subways are built. Lights cannot be served 200 or 300 feet off the line of the subways without a long underground connection, the cost of which would, in nine cases out of ten, prove prohibitive.

I recently read an article in a Western paper, to the effect that the wiring of the plant located in the city in which the paper was published, was all overhead, because the underground systems in New York City and elsewhere had proved to be a failure on account of gas explosions, which were so serious and frequent in their nature as to make the operation of high-tension currents underground infinitely more dangerous than dynamite. Now, as a matter of fact, although it is true that the earth beneath the street pavements of New York City is completely saturated with gas, but very few explosions have actually occurred and those not at all serious in character. Only one interrupted our business, and, in that case, only for a few hours and on but two circuits. The Subway Company use a system of blowers, which keep the subways reasonably free from gas, and this source of danger or interruption, at least so far as the city of New York is concerned, may be wholly disregarded. Nevertheless, without the blowers it might be reasonable to apprehend danger.

THE FINANCIAL ASPECT.

A good system of underground conduits fairly covering the electric lighting territory of a large city, will, in my opinion, cost on an average from $2,500 to $3,000 per mile, per duct, but, in the case of a single duct in a trench, the latter figure is likely to be exceeded, depending largely upon the character of the digging and the engineering difficulties to be overcome. For the purpose of comparison, however, let us assume $3,000 to be the cost of one mile of distributing duct and then consider the cost of one mile of construction for one arc and one incandescent circuit, by both underground and overhead methods, as follows:

UNDERGROUND.		OVERHEAD.	
Duct	$3,000.00	50 poles prepared and set at $12.00	$600.00
11,000 ft. No. 4 cable at 20 cents, laid	2,000.00	11,000 ft. No. 4 wire, at 4½ cents	495.00
11,000 ft. No. 2 cable at 30 cents, laid	3,300.00	11,000 ft. No. 2 wire, at 7¼ cents	797.00
40 house connections at $75.00	3,000.00	40 house connections	480.00
Total	$11,500.00		$2,872.50

Hence, from these figures, it must be assumed that the initial investment for an underground system will exceed by about five times the cost of an overhead system, and the fixed charges on this very expensive feature of investment in a central station plant must be correspondingly increased.

But in New York City, as before stated, the underground conduits are owned by a subway company, who have an exclusive franchise and who lease their ducts to the various electric light companies upon the following schedule of rentals:

Distributing ducts,		$1,000	per mile	per annum.
Trunk ducts, 3	inch,	900	"	"
2½	"	800	"	"
2	"	700	"	"
1½	"	550	"	"

These rates have the effect of increasing the usual and ordinary expenses of a central station enormously, and, although some overhead wires are still in service, and our field of operation is almost wholly confined to the more important streets and avenues, *the amount of the duct rental already equals the combined cost of coal, water, oil, waste and the salaries of chief engineer, engineers, firemen, coal handlers, boiler cleaner and oilers employed in the engine department.*

The development of electric lighting territory is, consequently, much restricted, and streets which would offer fair inducement for overhead wires cannot be considered at all from an underground standpoint. A case of this kind occurred in our last bidding for street lights. A certain company bid for the lights on Fifth avenue, between Twenty-third and Forty-second streets, about fifteen in all, at the rate of 60 cents per light per night. This was 20 cents above the ruling price. Being called upon to explain, the company stated, First, That there was no commercial arc lighting to be had in that locality whatsoever, and they must rely solely upon the street lights for revenue; Second, That there were subways on both sides of the street and that, as the lights were distributed on both sides of the street, they would be obliged to lease a duct on each side; Third, That, therefore, the duct rental *on Fifth avenue alone would amount to 32 cents per light, per night.*

There is another onerous feature which discourages the extension of territory, and that is, that the Subway Company requires us to execute a bond agreeing to pay rental for a term of five years on all new ducts constructed and this bond must be secured by collateral of unquestionable value. This ensures the return of their capital, even at their own estimate of cost, but it imposes a heavy burden upon the electric lighting companies.

And right here it seems pertinent to remark that I have long been convinced that it is a matter of paramount importance to an electric light company to own the subways it occupies and to possess the right to extend the same as the development of its business may require. While I have no complaint to make against the Subway Company of New York, I know that the subways could be operated by the companies for much less money than they are now required to pay, taking into full consideration the matter of interest on capital investment, cost of maintenance and operation, and every other charge which can be justly considered. Therefore, for those to whom opportunity is yet given, it might be wise and prudent to at least secure the right to construct underground conduits, even although they may not adopt their use for some time to come.

As to maintenance, our experience with cables has not been sufficiently great as to give us a definite idea as to their possible life. Aside from this, however, it costs no more to maintain the cables than it does to keep overhead wires in good order, say, from $15 to $20 per mile per annum—probably not quite so much; but, unless the cables last at least 20 years, the cost of maintenance is also likely to be far greater.

Finally, summing up the whole situation, the following conclusions may be fairly reached:

First. The underground service is not only a physical possibility, but an established fact upon a very large scale.

Second. It is less liable to interruption than overhead wires.

Third. It is less dangerous to human life.

Fourth. Its cost is enormously greater.

Fifth. It is cumbersome to a degree and lacks, to a considerable extent, the flexibility of overhead wires.

Sixth. Its cost precludes its extension to sparsely lighted districts, which must either be reached overhead or permanently abandoned.

TRANSMISSION OF POWER WITH SPECIAL REFERENCE TO THE FRANKFORT PLANT.[1]

BY CARL HERING.

This lecture was one delivered with special reference to the proposed transmission of power from Niagara Falls to Buffalo, and its feasibility as illustrated by the recent work at Frankfort with the transmission from Lauffen. Mr. Hering presented a very interesting statement of the general conditions of the problem, and then described the manner in which the experiments at the Frankfort Exhibition were carried out. He also explained in an admirably lucid and simple manner the nature of the three-phase rotary current used and its difference both from the two-phase current and from the ordinary oscillating current generally used in alternating work.

Mr. Hering closed his lecture with the following passage:

"The Oerlikon Company gives the following figures regarding the cost of the plant: Assuming that 300 h. p. is developed at Lauffen, and that all the energy received in Frankfort was converted into light, the cost of the plant per effective horse power measured at the terminals of the lamp will be about $282, of which $236 is for the line alone. These figures appear high, but it must not be forgotten that in this particular plant there were conditions which would not be likely to occur in practice, namely, relatively small power on the one hand, and exceedingly great distance on the other, both of which factors naturally increase the cost per horse power.

"It may be of interest to add herethat Mr. Dobrowolsky of the Berlin firm states that he would be willing to bid on the contract to transmit 1,000 or 5,000 h. p. from Niagara to Chicago, a distance of about 500 miles. He proposes to use 40,000 to 50,000 volts and claims that an efficiency of 60 to 75 per cent. could be obtained without difficulty."

He also added the following:

"I received this morning a letter from the Zurich people, the Oerlikon Co., who you may know have put in a bid for the transmission of power from Niagara Falls to Buffalo. They propose that the current generated at the Falls is to be such that both motors and lamps—arc lamps as well as incandescent lamps—shall be used. That is, the current shall be fit for motors, arc and incandescent lamps. They say the Drehstrom (that is, the rotary) current is at present, and will be for a long time to come, the only practical form of current to run large motors of a fair efficiency. They propose to use 50 periods in place of 40 which were used at Lauffen, because they say that 40 is too low to run arc lamps. Fifty is said to be the lowest at which arc lamps will run satisfactorily. The generating station would be composed of units of 5,000 h. p. each. The dynamos must therefore be of 5,000 h. p. According to the wishes of the turbine designers the number of revolutions has been fixed at 250 per minute. The diameter of the armatures has been fixed at 3¼ metres, that is about ten feet. The armature is to be drum wound. I suppose that means the drum winding on the surface of the cylinder, that is, not across the ends as we usually wind drum armatures here, but wound as they very often do in European multipolar machines. The currents are to be 2,000 amperes in each of the three circuits, and the voltage 600 to 700. It has been found advantageous to revolve the armature instead of the magnetic field, in order to have a minimum weight on the vertical shafts. The weight on one of those shafts, by the way, is something very great. The shafts are 20 feet long, and the weight of the shafts together with that of the armature and turbine is a very great weight, and must therefore be considered. The generators will have 24 poles.

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[1] Abstract of lecture delivered before the National Electric Light Association, Buffalo, February 23, 1892.

They will be separately excited. The efficiency will be in the neighborhood of 96 per cent., that is the efficiency of the dynamo including exciting power. There will be two transformers, as it was not found practical to build a single transformer of 5,000 h. p. The transformers will be artificially ventilated, and only the high pressure coils will be placed in oil. These transformers will raise the potential to 25,000 volts.

"This" they say, "is no longer to be looked upon as an experiment. The cost of the line will be about 100,000 francs, that is, $20,000, an almost trifling part of the whole, for the total distance. It is a simple pair of copper wires, that is, three pair of copper wires on poles; the cheapest kind of a line.

"As to the line, we propose not to carry any more than one or two units of 5,000 h. p. on one line, of poles for a number of reasons. A 5,000 or 10,000 h. p. can be conducted on wooden poles at a very moderate initial cost of plant. The lines would terminate in one or more step-down transformer stations that would supply current of 1,800 to 2,000 volts for municipal and street lighting in the shape of alternating currents to be transformed down to the suitable lamp voltage, as is the case in the present transformer systems. The cost of the electrical part of the proposed plant, including the generators, exciters, and transformers at both ends of the line, would be about $180,000 for each unit of 5,000 h. p., with an efficiency of 84 per cent. at the low pressure terminals of the secondary transformers. This reduces to $36.00 per horse power. The cost of the line is about $4.00 per horse power, which is about 10 per cent. of the whole."

At the close of the lecture, Mr. Hering showed a number of magic lantern slides illustrative of the Frankfort-Lauffen apparatus, line, exhibition, etc.

Prof. Elihu Thomson followed in a most interesting address, in which he expressed himself not only as greatly in favor of the three-phase method, but as perferring an underground line, for which purpose he suggested an iron pipe filled with oil. Then the higher they ran their potential the less danger would there be from lightning. Their plant would be constructed to withstand a moderate phase of lightning, and it would then take considerable to break it down. With sufficient oil, they could easily run up to 100,000 volts.

Mr. H. Ward Leonard then read a brief and well-put paper[1] arguing for the necessity of a combination of the alternating transmission with a direct current distribution. He said, too, that all the problems could be solved with existing apparatus and methods embodying it.

Mr. L. B. Stillwell remarked that the work done abroad had been carried on with Government help, and was practically paid for by three States. There certainly were manufacturers here ready for any kind of work, with such a guarantee of payment. As to the technical side of the matter, there seemed to be reasons for thinking that a two-phase, 90 degree system, was preferable for combination work, *i. e.*, where more than one motor was run or where motors and lights were run together. With regard to a synchronous plant at Telluride, mentioned by Mr. Hering, he said that the current was transmitted 2¾ miles at 3,300 volts, with the intention of going eight miles to other motors. The present motor was running 24 hours at least six days in the week. Mr. Stillwell also said that he failed to see the necessity for step-up and step-down transformers for any distance of less than 10 miles. Moreover, in some places oil insulators could not be used, owing to the fact that the line was set at all angles, so that the fluid was spilled. At Telluride, ordinary glass had been used successfully all through the winter.

Mr. C. S. Bradley spoke of his pioneer work in rotating fields, and expressed his preference for three-phase methods.

Dr. Louis Bell discussed the whole question in an eminently shrewd, practical manner, showing that while something had been done there was still much to be learned, especially with regard to the relative values of the methods employed.

"In the present situation it does seem to me that a great deal of the discussion between the defects of the various systems ignores for a moment that much of what is to be done in the next year or two must be done under the conditions where we are working now. Much of it must be done with existing apparatus, and the man who will make the most thorough success of the transmission of power in that field is he who will attack each separate problem, doing the best he can with the apparatus which he can get, and not tying himself up absolutely to either continuous or direct currents, to two-phase, three-phase, or any phase motors, but seizeing the opportunities for transmission of power as they come, and making the best of the situation with the best apparatus that that particular moment commands. It is this practical, commercial side of the problem that I think one is half apt to forget in the glory of electrical pyrotechnics."

At this point a discussion arose as to cost of the plant and line, Mr. Carl Hering having given figures which were generally considered to be too low, namely, $36 per horse power for the entire Niagara-Buffalo plant, including dynamos and all, up to 2,500 h. p., with $4 per horse power for the line. Mr. Leonard remarked

(*Concluded on page* 221.)

OVERHEAD CONSTRUCTION.[1]

BY E. F. PECK.

In view of the great interest taken at present in underground construction, it would seem almost incongruous to agitate the well-worn subject of overhead construction. Still, as the majority of electric lighting companies in this country will have to contend with this method of construction for some years to come, it may be that the subject will still be debatable. In order to bring out a discussion that will, I trust, prove both interesting and instructive, I will outline some recent work that has been done under my supervision in Brooklyn.

We had reached that point where further patching was out of the question, and reconstruction became a necessity. The first point of attack was our switchboard. This was the old style plug, socket and cable board, with wooden framework, originally designed for 36 circuits and 36 dynamos, but now, due to the increase of our business, handling 53 circuits and 42 dynamos.

The switchboard that I have planned is arranged to manipulate 80 circuits and 66 dynamos, divided into three units, which I will describe as sections A, B and C—circuits and dynamos in each section being interchangeable—section A to provide for 32 circuits and 22 dynamos, and sections B and C each providing for 24 circuits and 22 dynamos. Each section consists of two rectangular slate slabs, placed five inches apart, supported on a suitable framework of steel I beams and channel bars, occupying three sides of a square. Into these slabs are fitted rows of metal bushings which are properly connected together by copper strips, so that the horizontal rows of bushings on the front board are connected to the dynamos *via* single throw jack knife safety switches, while the vertical rows on rear board are connected to the circuits and also to an extra row of bushings on the bottom of front board. This extra row is used to connect two or more circuits together by means of cables and plugs, the connecting of dynamos to circuits being done by means of an ordinary plug of brass tubing, provided with an insulated handle. Above the switchboard proper, which stands about five feet high, slate slabs extend to the ceiling of the room in which the board is located, providing space for necessary lightning arresters, combined ammeters and polarity indicators, to be used on each circuit.

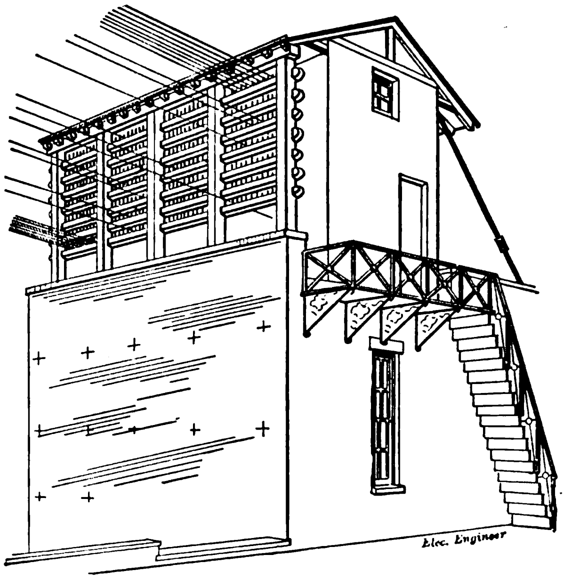

FIG. 1.

The next improvement which became necessary was the building of a suitable wire tower. The wire tower of a central station is an unknown quantity and a problem that is hard to solve. The first question is as to its shape. Shall it be rectangular, octagonal or circular? This can only be answered by one having a thorough knowledge of the situation of the station and the directions which the circuits are to take after leaving the same.

While at Montreal, I saw a very pretty arrangement of a wire tower on the new station of the Royal Electric Company. It was octagonal in shape, each side being about 10 feet wide, with a rectangular section of slate framed into each section. This permitted the introduction and insulation of wires without other precautions, and, owing to the shape of the tower, provided for a lead for the circuits in eight directions. In our Brooklyn station, it was necessary to have the wires leave the tower in one direction only; so it was built rectangular in shape (see Figs. 1, 2 and 3). The tower is built directly over the switchboard and is 23 feet long and 10 feet wide. The framework of the tower,*inside wire rack and outside wire rack, are all framed and bolted together, and guyed to the roof in the rear of the tower by means of wrought iron rods, provided with turn-buckles. The front, or side through which the wires enter, is made up of two thicknesses of two-inch plank laid diagonally to each other and fastened together with wooden pins. This was done to insure sufficient strength without framing and to permit the promiscuous boring for glass bushings. The inside finish of the tower is of hard oil varnish, and the outside of three coats of insulating and fire-proof paint. The roof is of slate, the eaves of which extend over the outside rack, thus, to a certain extent, sheltering it from the weather. At the bottom of the inside rack of the tower is an auxiliary slate switchboard of very simple construction, consisting of two rows of metallic bushings and binding posts. By the use of plugs and cables on this board the tangles and cross connections, incidental to all central stations are confined to this particular point. This arrangement also permits the transferring of circuits to any one of the sections of the main switchboard, thus adding to the flexibility of the entire system. From the outside rack, the wires are carried to a distributing pole (see Figs. 4, 5 and 6) of Norway pine set directly opposite the center of the tower. This pole is 92 feet long, 30 inches in diameter at the butt, 18 inches in diameter at the top, and is set 12 feet in the ground to insure stability. This height was necessary to allow wires to clear a three story building to be built in front of the wire tower. On this pole are fitted 11 double sets of eight pin arms, and 11 double sets of 16 pin arms, a total of 44 arms, providing for 176 wires, or 88 circuits. The 16 pin arms are set parallel to the arms on the tower rack, and the eight pin arms are at right angles to same, to enable wires to run north and south. These arms are of the best quality of long-grained oak of the following dimensions: Eight pin arms are eight feet long, three and three-quarters inches by four and one-half inches, pins nine inches between centers—excepting pins nearest the middle of arm, which are three feet between centers, to allow a man to pass between wires when ascending the pole. Sixteen pin arms are ten feet six inches long, four inches by five inches, with pins six inches between centers. The pins used on these arms are of selected locust, one and one-half inches in diameter, and the glass insulators are of the deep grooved double petticoat pattern. The bracing and fastening of the arms can best be seen by referring to the sketch.

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[1] See Page 215.

[1] Abstract of a paper read before the National Electric Light Association, Buffalo, Feb. 24, 1892.

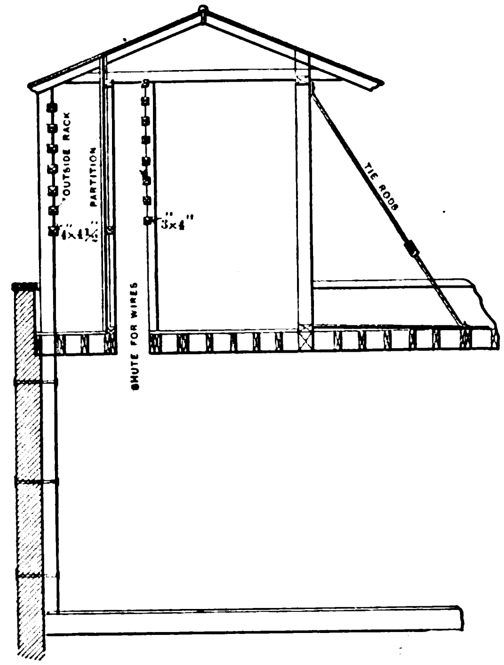

FIG. 2.

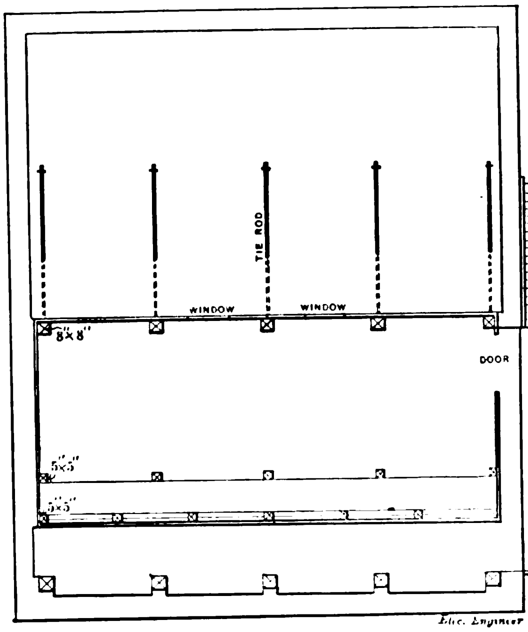

FIG. 3.

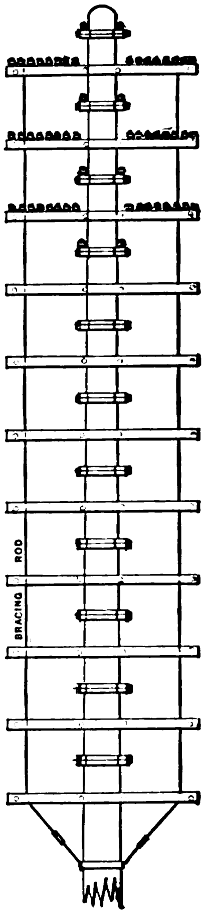

FIG. 4.

From this point the poles gradually decrease in length until a height of 50 feet is reached, which height is maintained on all our main lines. On lines carrying from eight to sixteen wires octagonal chestnut poles are used, 35 feet long, 10 to 12 inches at butt and six to eight inches at the top. Lamp poles are of the same material and shape, 24 feet long, eight inches at butt and six inches at top.

Particular attention is paid to the guying of poles where necessary; and we are using for this purpose four No. 6 B. & S. galvanized iron wires twisted together to form one strand, and introducing turnbuckles on all main guys. This wire is purchased made up in this manner, and we find it a great improvement and saving over the old method in vogue, of allowing linemen to waste their time in making up guys as needed.

While on the subject of poles, I wish to call attention to what I consider an erroneous method of treating poles to preserve them which is practiced by many companies. Pitch or tar is applied to the butt, thus confining the sap, which ferments and hastens decay. There are many different ways of treating poles, but I know of no method which is successful unless applied to the entire pole. The well-known creosoting process is objectionable on account of the dirt and the unpleasant odor connected with it, as well as the fact that the creosote does not penetrate to a sufficient depth. The same objections apply to the Burnettizing and Kyanizing processes. My attention has been recently called to the Haskins process, which seems to be highly successful. This process consists in the placing of timber in an air-tight retort and subjecting it to the heavy pressure of superheated air, which permeats the whole section, thereby accomplishing the same result as a charring process, without altering any of the chemical properties of the wood.

In regard to the character of wood to be used for poles, the choice is limited in the vicinity of New York, those obtainable being chestnut, Norway pine, Princess pine, cedar, yellow pine, spruce and white pine. The Princess and Norway pine, although not as durable as chestnut, are the most desirable for the heavier poles, on account of their straightness and size. For lighter work, I prefer hewn or sawed chestnut poles to all others, and they are still obtainable in lengths up to 40 feet. Cedar poles are excellent as far as life is concerned, but too crooked and knotty to be useful for first-class work. My experience with yellow pine, spruce and white pine has been very discouraging, the life of each being short and uncertain.

The next step in the way of improvement which suggested itself was a better method of hanging commercial lamps. It has always been a source of surprise to me that more attention has not been paid by lighting companies to this important matter. The small additional expense necessary to ornament these fixtures certainly ought to warrant an improvement. I have in use a fixture adopted by us which is not expensive, but neat in appearance, and it allows of a subtantial method of wiring without the use of other appliances. The fixture is made of wrought iron pipe, excepting the flange or T, which is of cast iron.

The scroll work in an ornamental fixture has been arranged to permit the introduction of the initials of the firm in front of whose store it is placed. The scroll letters are gilded, while the remainder of the fixture is black. The effect is both pleasing and attractive.

Last in the line of improvements came the wiring. It was only a question of rubber covered wires *versus* weather-proof.

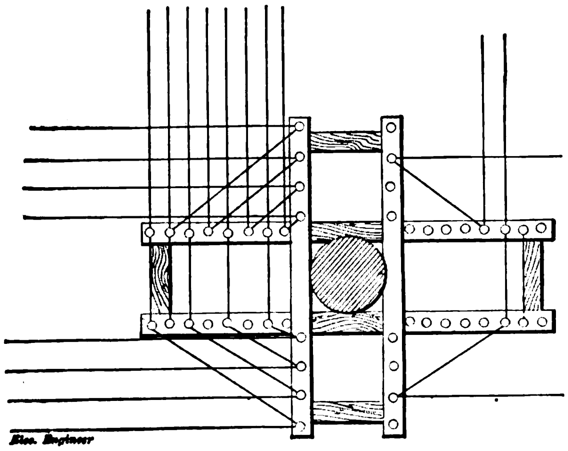

Fig. 5.

We compromised the matter by using the best grade of rubber covered wire for all leads from the switchboard to the main poles, and on all lines crossing under telephone and telegraph or uninsulated wires. For the balance of the reconstruction the best grade of weather-proof wire was used. It will be noticed that I have used the term "best grade" for both classes of wire. This term is a little ambiguous, as I am reminded each day by our friend, the wire salesman, who claims that his brand of wire is the best and that all other kinds are not in it. So it remains for the purchaser to judge for himself as to the respective merits of the different brands in the market.

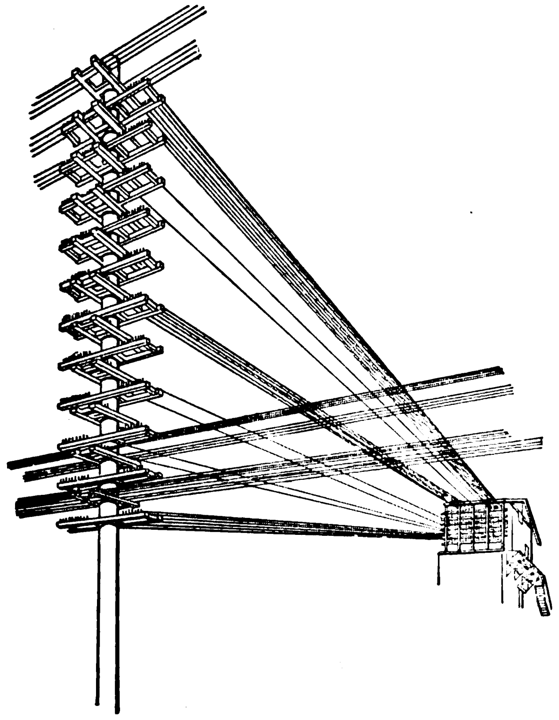

Fig. 6.

On some of the loops to buildings, where two or more circuits were necessary, we have used, with great success, duplex cables, thus doing away with a complicated and unsightly network of wires and fixtures. All wires are run on deep groove double petticoat insulators, the use of rubber hooks and porcelain knobs being avoided. It would be difficult to formulate rules for this branch of construction, it being simply a question of judgment and experience. However, a few suggestions may not be amiss. Great care should be used in the stringing of wire, for the insulation of a whole circuit may be ruined by the carelessness of linemen in handling. Joints should be soldered on all electric light work when possible. I have found that wrapping a joint with tin foil, and then covering with a good rubber tape, makes an excellent substitude for soldering, and is easily applied. Keep wires on the same relative pins to the end of the line, thus avoiding confusion, and making it an easy task to locate trouble.

Diagrams of principal poles, showing location of circuits, should be kept in every central station, for they are often the means of preventing serious trouble. Do not leave loops up that are out of service, expecting to pick them up again, as they may become a menace to your live wires. If more attention were paid to overhead construction by the electric lighting companies, substantial, neatly-painted poles being used, with well insulated wires kept taut and thoroughly inspected, the everlasting hue and cry against the "deadly" electric light wires would soon change to one of commendation and praise.

DISCUSSION ON MR. HERING'S PAPER.

(Concluded from page 219.)

that such prices were impossible in this country. Mr. Martin also doubted the statement as to a periodicity of 40 or 50 per second having been attained, and said that he understood it had ranged below 25. This was confirmed by Mr. Bradley, who said that it seemed difficult to get above 28. Mr. Martin also questioned whether it could fairly be said that the losses had all followed Ohm's law; the static conditions of the line had been abnormal and severe. He suggested that perhaps the Standard Oil Co. might lend them for experiment one of their pipe lines.

Mr. Stanley—It may interesting to the members of the Association to know that there is a line of 15,000 volts in operation in this country. We have constructed a small line at Pittsfield using 20 h. p. and fed by the station currents, the line starting at the outskirts of the town and making quite a little circuit. We find that there is practically no difficulty whatever at that potential; 15,000 volts, however, is a very different matter from one, or two, or three, or five, or ten, or twelve thousand volts. The striking distance at 15,000 volts is apparently two or three times what it is at 10,000 volts. For instance, if a wire hangs down from the line within an inch or two of the ground there is a most delightful aurora borealis between the ground and the wire; and if a dry board be interposed in the circuit—an ordinary pine board—it does not seem to affect the resistance of the circuit a particle. It goes right through it. We are making these tests at Pittsfield to become familiar with this question from a commercial standpoint, and have undertaken to transmit 400 h. p. for lighting purposes a distance of 28 miles in one place in this country. The delightful lecture given by Mr. Hering does not, however, give us some of the points which as engineers and as practical men we need in examining and testing the merits of the various devices. For instance, Mr. Swinburne wrote me the other day that from information he had received the Dobrowolsky motors—two horse power motors—required 4,200 watts to run at no load and 14,000 watts, or 10 times its rated capacity to run it at its full load, I do not mean that 14,000 watts are expended in the circuit, but I do mean that of the current apparently applied, viz., 14,000 watts, but 1,500 are actually useful. If this is an example of the engineering practice on the other side, I am very certain that my friend Mr. Stillwell can tell us that it is far below that obtained by Tesla. If I understand them correctly, the Tesla motor uses about .6 of its full load current to run it empty, .7 of which is usefully applied. That is to say, about .7 × .6 × the total energy, is required to run the motor empty. The synchronous motor has certain very beautiful applications, but it has a very serious defect in my judgment; that is, that when the motor is overloaded beyond a certain point, the motor not only stops, but it goes to pieces—burns up; or it is very liable to burn up. I do not see how any commercial system of distribution of power can be made when we have to start our apparatus by a weight as suggested by one gentleman; or by another motor, as suggested by another gentleman; or by three special circuits which will not work in multiple, except they work alone, the plan suggested by Dobrowolsky.

In the case of the transmission of power between Niagara Falls and Buffalo, I am quite certain that 15,000 volts could be loaded on the circuit between that place and this, but I am equally certain that no large amount of power can be transmitted successfully by the present apparatus. I mean with commercial success. If we are going to bring Niagara Falls to this city—or a small portion of Niagara Falls—we have got to adopt some scheme radically different from anything that has been presented up to the present; such as the scheme that Prof. Thomson suggested, and lay our wires at 100,000 volts pressure in an oil pipe. I cannot see that there is any half way solution of the problem.

Mr. M. C. Sullivan has been appointed New York agent of the New Process Raw Hide Co., with offices at the Electrical Exchange, 136 Liberty street, this city.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

VOL. XIII. NEW YORK, MARCH 2, 1892. NO. 200.

Modern science affords the best, the highest, and the most useful school of intellectual culture.—W. Mattieu Williams.

THE BUFFALO ELECTRIC LIGHT CONVENTION.

It is seldom that we have the opportunity to speak of a convention in such terms of praise as we feel inclined to use about the recent meeting of the National Electric Light Association at Buffalo. The reception accorded to the body by Buffalo and her citizens was most generous and cordial; the work done was of a high class right through, and there was a remarkable absence or suppression of "axe grinding," for which, presumably, we must thank a vigilant executive committee. The Association stands higher to-day in esteem and in results than ever before, thanks to the felicitous manner in which President Huntley has discharged the duties of his position; and he hands over to the competent hands of Mr. Ayer, of St. Louis, an organization in which central station men cannot but find a bulwark and a means of practical improvement.

A number of most excellent papers and addresses were delivered, and the advanced standard set by Mr. Huntley, in his address, and by Mr. Carl Hering, in his lecture on the Frankfort transmission, was maintained to the end. Mr. Stanley's paper on alternate current motors was an excellent exposé of the principles underlying the operation of these machines and of the difficulties encountered in their construction. Mr. Stanley believes that the reason why Mr. Tesla's motors are not more in use in this country is owing to the fact that the periodicity employed in alternating systems is too high; but the cause which we believe is the more probable one, is the fact that these motors require a special generator and at least three wires to produce the necessary phase difference. Messrs. Stanley and Kelly have set themselves the task of obtaining this difference of phase by a current splitter, which avoids the special generator and allows them to obtain any desired difference of phase. Their new type of alternating motor appears to resemble very closely the continuous current machine, in which special provision has been made to avoid currents flowing in the armature core, which they effect by a special close circuited winding directly enclosing the armature. The losses in the small motors of this type appear to be large, but they are in fact not much, if any, larger than those of the continuous current machines, although we believe it probable that larger sizes of alternating current motors of this design may not quite equal those of the continuous current type. Nevertheless it is apparent that if they can be placed upon the alternating current circuit they would have an unlimited field of usefulness, since efficiency alone is but one item in the many that go to make up a practical machine.

Mr. L. B. Stillwell's paper on "The Relation of Size and Efficiency in Transformers" is one that should be carefully studied by station managers. It has taken some time to develop the fact that the use of a large number of small converters is uneconomical, but exactly to what extent this is the case is now well shown in tables prepared by Mr. Stillwell. He shows that on account of the high loss in the iron in small transformers, coupled with the fact that the loss in the copper remains practically constant throughout the load, it is more economical to use a single transformer to supply any number of lamps up to one hundred in preference to a number of small ones of equivalent capacity. The discussion which followed Mr. Stillwell's paper brought out a remark from Prof. Thomson that in the ideal transformer the iron ought to be hot and the copper cold in order to obtain the highest efficiency, while Mr. Stanley inclines strongly to believe that the transformer of the future will have no perishable insulation whatever, so that it may be run at the most economical point, independent of its temperature.

The discussion on the amendments to the wiring rules showed that there are still questions to be solved in this field, notwithstanding the fact that much has already been done to tabulate the results of the best practice. The remarks of several speakers went to show that in more than one detail improvements in both the methods and the apparatus of distribution are still possible, and will have to be effected before they can be considered to fill the requirements of a safe apparatus.

Mr. E. A. Leslie's paper on the operation of high tension currents underground from a physical and financial standpoint and the discussion to which it led was one of the principal contributions to the work of the Convention. The paper itself was one of the best which has ever been presented at any meeting of the Association, and places in a clear light the enormous difficulties which have to be contended with in high-tension, underground work. Mr. Leslie shows the paramount importance of good joints and good laying, and we think it well to freely admit, as he does, the success of such underground cables when properly installed. His frankness in this regard we think would bring conviction with it to those who might otherwise stand aghast at the figures given in another part of his paper relating to the cost of underground work. Mr. Leslie showed that the cost of connection to city lamp posts, including pipe, labor and cables, averages no less than $110 per post, and to this initial cost must be added the enormous cost of the rental of duct, cost of cable, etc. This he shows, as compared with the overhead system, to be five times as expensive for the same service. The enormously increased difficulties of earning dividends under such circumstances, and the restrictions which a company forced to go underground would suffer thereby, ought to be sufficient to awaken to a sense of responsibility those who blindly advocate burying all wires irrespective of the conditions involved.

One of the most encouraging features in connection with the Buffalo Convention, and one which the members were not slow to acknowledge in words of appreciation, was the fact that such men as Prof. Elihu Thomson, Mr. Wm. Stanley, Jr., Mr. L. B. Stillwell and others attended all the sessions and freely gave to the members their experience on the numerous points involved which were brought out in the discussions. The value of the presence of men who have created the apparatus employed and who know its character, perhaps better than any one else, is so apparent as to require no further pointing out on our part; and we consider this one of the most hopeful evidences that the Association commands the attention of electrical workers and engineers as well as that of the central station men, thus illustrating the fact that success achieved by the one means the success of the other.

Owing to the fact that no paper was presented at the meeting bearing specifically on the subject of steam engineering in connection with electricity and its distribution, this subject received no attention whatever. This is somewhat to be regretted as the marked changes which have taken place in this direction would have been sufficient to form the basis of an interesting discussion. Notwithstanding this, we think, without seeking to make any invidious comparison, it may be truthfully said that in the point of practical information as regards the papers and discussions, and in the interest manifested by the members throughout, the Buffalo Convention was the best, thus far held, in the history of the Association. This meeting has demonstrated the fact, if such demonstration was still required, that the Association has a *raison d'etre*, and what is more, that it has a mission to fill the importance of which is increasing day by day.

ELECTRIC LIGHTING FROM A FINANCIAL STANDPOINT.[1]

BY ERASTUS WIMAN.

HAVING in the process of time developed a large demand for light, evidences of which are seen on every hand; having at the same time gone through a most unusual experience in not only creating that demand, but in the production of the article for its supply, a review is in order as to the present position of electrical securities and the prospect of profit. It may as well be admitted that there has been a serious and costly struggle, and that, taken as a whole, the results in the shape of a total profit on the total investment in electric lighting is not to be seen in the shape of dividends. There are, however, happily, exceptions to this general statement, and in the returns sent to me from all parts of the country, there are a considerable number of companies whose career has shown that in electric lighting there resides the potentialities of a profit, equal to that of any legitimate enterprise. The successful companies illustrate what it is possible to do, and though they may not be numerous in comparison with others whose record for profit is small or who report a loss, yet that money can be made continuously and rapidly out of electric lighting is clearly demonstrated. In order to cite an example of steady growth in revenue, and also to show the corresponding ratio of expense, I append the figures for seven years, from one of the most successful companies in the East, whose management has been characterized by the highest ability, and whose location and name it would hardly be proper to disclose. The figures are authentic, and show a record of which any man might be proud.

EARNINGS OF AN ELECTRIC LIGHT COMPANY.

For 1885—Receipts	$30,768.70
Expenses	24,901.54
Net earnings	$5,867.16
For 1866—Receipts	$47,613.76
Expenses	34,700.83
Net earnings	$12,912.93
For 1887—Receipts	$57,750.71
Expenses	34,691.85
Net earnings	$23,058.86
For 1888—Receipts	$75,734.14
Expenses	46,235.83
Net earnings	$29,498.31
For 1889—Receipts	$135,254.08
Expenses	94,178.69
Net earnings	$41,075.39
For 1890—Receipts	$199.195.72
Expenses	150,195.48
Net earnings	$49,000.24
For 1891—Receipts	$247,679.88
Expenses	187,092.77
Net earnings	$60,587.11

The company commenced to pay dividends January 1, 1887, at the rate of 8 per cent., payable in quarterly dividends of 2 per cent., and have continued the same up to date.

Before closing the books December, 31, 1891, there were charged off from the earnings of 1891, for depreciation, $10,000 from the steam plant. and $30.000 from the electric plant. On January 1, 1892. capital stock $800,000, surplus $90,000.

The above figures speak for themselves, and in the progress shown in receipts and profits there is contained a hopeful sign for many another company whose career up to this time has yielded an inadequate return. Indeed, to present a totally different picture, here is an extract from the letter of an esteemed Western friend that shows the ruins of a senseless competitive struggle and the folly of low prices:

"I am the president and manager of five electric light companies in this city, but *three* of which have actually survived financial pressure and bankruptcy. One of these three, with a a capital of $150,000, fell behind nearly $100,000 in seven years, and last year the stockholders voluntarily came up with an assessment of $60,000 to save it from bankruptcy. Another, working under the strictest economy, is but barely able to meet operating expenses. Still the other, a foundling of the Gas Company, is, under exceptionally favorable conditions, and paying no salary to its executive officer, making a little money; after 18 months' operation, it last month declared a dividend of 3 per cent."

With such an experience it is no wonder that the gentleman writes as follows: "I am aware that books can be kept so as to show an earning, but this is in many cases at the expense of a constantly depreciating capital investment."

As a matter of course the profitableness of any undertaking depends upon the prices obtained. In my judgment electric light projectors are themselves to blame for loss of profit through false representations as to the economy of operations. If the truth had been told, and contracts refused except upon a paying basis, the electrical business throughout the country would now be upon a much better footing.

The promoters of electrical enterprises, and the sellers of electrical apparatus and appliances are rapidly killing "the goose that lays the golden egg" by falsely representing the great economy of operation, and consequently the great profits of such undertakings, thus falsely educating the public into the belief that anything like a reasonable price is extortionate. The true policy of the friends of the electrical industry should be directed in just the opposite course to that which you propose pursuing, namely, to show that electrical undertakings upon the basis of the present prices *are not profitable*, and if they expect perfect service they must pay better prices, prices that have prevailed because the companies themselves have not heretofore appreciated and understood the cost of operation, and the great loss due to accidents and rapid depreciation.

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[1] Abstract of a paper read before the National Electric Light Association, Buffalo, February. 24, 1892.

FROM THE TANNERY TO THE DYNAMO.[1]

BY CHAS. A. SCHIEREN.

It may be of interest to engineers, and the electric light fraternity in general, to learn something of how leather is tanned, and the various processes through which a hide passes before it is tanned and curried ready to be put into belting. Naturally, the first question will be, "Where do all the steer hides come from?" Principally from Chicago, because within its city limits there are four large slaughtering establishments where thousands of cattle are slaughtered daily, the hides of which are carefully taken off and assorted for whatever purpose they are best suited. The hides which are heaviest and most perfect in point of freedom from cuts, brands and other blemishes, are selected for belting leather. These hides are put up in bundles, packed into a freight car, and shipped to the tannery.

We propose to follow one of these freight cars loaded with belting hides to its destination. After a journey of about 600 miles, the car arrives at the little station of Adamsburg, Pa., right in the mountain region, a spur of the Alleghenies, where the tannery is situated.

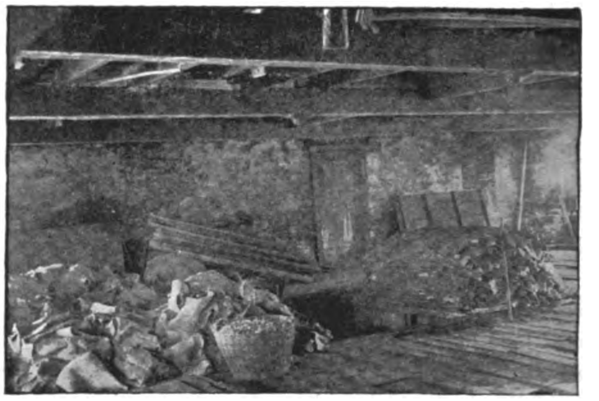
Oak tanneries are generally placed near the bark region of the mountains, where the rock oak tree predominates, the bark of which is universally conceded to be the best for making the finest grade of leather. It is interesting to watch the mountaineers fell the huge oak trees, and skin the bark from the same. This is generally done in the springtime, and tanners have to purchase their year's supply during the bark peeling season, which is from the middle of May to about the middle of June, according to the condition of the weather; the season seldom lasts over six weeks. If the sap rises into the leaves the bark cannot be taken off, and, therefore, oak trees are only cut down in that period.

The peeling of the bark is done wherever the trees are felled; the bark is gathered together in small stacks and covered to protect it from getting wet, because the strength of the tannic acid is lost by the bark getting wet; it must also be carefully guarded against mildew. Mountain fog is very damaging to peeled bark, therefore the mountaineers load the bark in wagons and deliver it as quickly as possible to the nearest tannery or railroad station.

UNHAIRING HIDES.

However, our car of belting hides has arrived at the station, and we will watch the process of tanning. The hides are examined and weighed, and put into the shed; an equal number of hides are taken out daily (whatever the capacity of the tannery may be), and placed in a large vat of pure cold water, generally good spring water. After the hides are thoroughly soaked and the dirt washed out, they are laid across a beam and, with a blunt fleshing knife, the surplus fat or meat still remaining is taken off; then they are placed in a vat of weak lime water, and are hauled up daily and the lime strengthened until the hair gets loose, which action takes about eight days. After this the hides are cleansed once more in pure water and placed over the beam and, with a blunt knife, the hair is removed; this part of the work is done in what the tanners call the beam or lime house, and very much depends upon the successful liming process in making good leather.

After the hair is off, the hides are washed again and thoroughly cleansed and purified, to remove every particle of lime, after which process they are taken into the handlers. These are composed of large vats, about seven by nine feet, and six feet deep. The hides here are laid across sticks side by side, as close as possible, and hung about three inches below the top of the vat. These vats are generally connected so that when the first vat is fed the tannin liquor will pass through every vat until they are all filled, and cover the hides completely. In the handlers the hides receive their first bath of tannin liquor, which is very weak at the start, and gradually strengthened. During this first stage of tanning the hide plumps up, and is prepared for the lay-aways; this process also opens the pores and swells the hide, which gives thickness and firmness to the leather. If the hides cannot be made thicker at this period of the tanning, they will never be made heavier afterward; this is the critical point and has to be watched closely. Much depends upon the character of the tannic acid; if too strong, it tends to make the leather brittle and harsh; if the tannic acid should be too sour, it tends to make the leather soft and flabby.

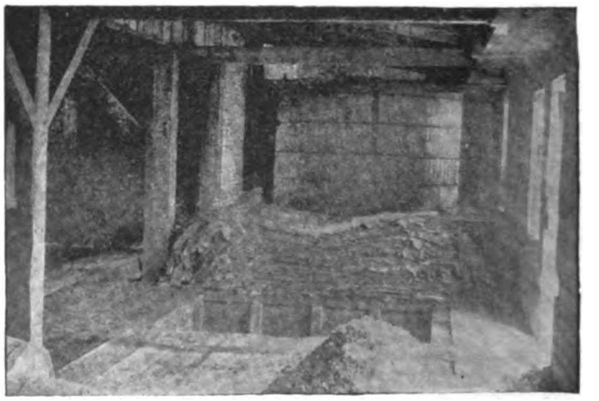


TRIMMING HIDES FOR LAY-AWAY VATS.

Some tanners use a rocking process to keep the hides in motion, thereby opening the pores of the hide quicker to receive the tannic acid; however, opinion differs as to the utility of the rockers, some claim (and justly) that the rocking motion loosens the fibre of the hide, and softens the leather too much. The best process is to simply hang them in the vats and cover them with the tannin liquor, and raise them a few times during the day, or draw the liquor through them, which some tanners are now doing with success.

The tannic acid in the handlers generally has a strength of from five to fifteen, very seldom over twenty degrees. The hides remain in that process from ten to twelve days; they are then taken up and, if they are to be used for belt leather, the flanks (bellies) and heads of the hides are cut off and tanned separately; the remaining butt part receives an extra layer of bark to tan it more thoroughly and make it firmer.

From the handlers the hides are packed away in vats, called lay-aways; these are large vats seven by nine feet, and six feet deep, having a capacity of from fifty to seventy-five hides each. The vats are not connected with each other, but only with the pump to change the liquor. The hides are laid nicely one on top of another, and loose ground bark spread between each hide, and when the vat is full it is filled with tannin liquor of from twenty-five to thirty degrees in strength. The hides intended for belting receive at least six layers of bark, or in other words, are changed six times in the lay-aways; the first time they are changed after lying ten days, and then five days are added after each layer, so that the hides in the last or sixth layer will take forty days to absorb the tanning liquor and penetrate the leather. Each time fresh ground bark is spread between the hides and then covered with tannin liquor.



TAN PITS AND FEED TANK.

The leaching and grinding of the bark is an important factor in a tannery. The large pieces of bark taken from the oak tree are thrown into a hopper-shaped mill or grinder, which resembles a coffee grinder on a large scale. The ross on the outside of the bark creates a great deal of dust, and contains little or no tannin, but it cannot be severed from the rind which really contains the acid; from the bark mill the ground bark is elevated into large tubs which have false bottoms, or receivers underneath to take up the tannin liquor. After a tub is filled with ground bark, a rotary sprinkler is set in motion to saturate the bark with a spray of water or liquor, which percolates through the ground bark, and on its way to the bottom catches up the tannic acid contained in the bark; at times warm water is used to facilitate the operation, also weak tannin liquor is used sometimes with good effect; however, old school tanners prefer cold water, which they claim makes purer and sweeter tannin liquor. After the receivers at the bottom of these tanks are filled, the contents are pumped into large supply tanks, from which the liquor is distributed through the tannery as required.

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[1] Read before the N. E. L. A., Buffalo, Feb. 24, 1892.

The leaching process is the most interesting and valuable operation in the tannery, and upon its skillful management depends the financial success of the business; opinion differs very materially as to the best method. The large round leach tubs, such as described, are the most popular now in use; however, many tanners still adhere (and some with success) to the old square passed leach tubs, in which the ground bark is simply soaked or steeped in water and left for a length of time, until the tannic acid is extracted from the bark. Opinion also differs as to using steam or hot water; however, all have their merits.

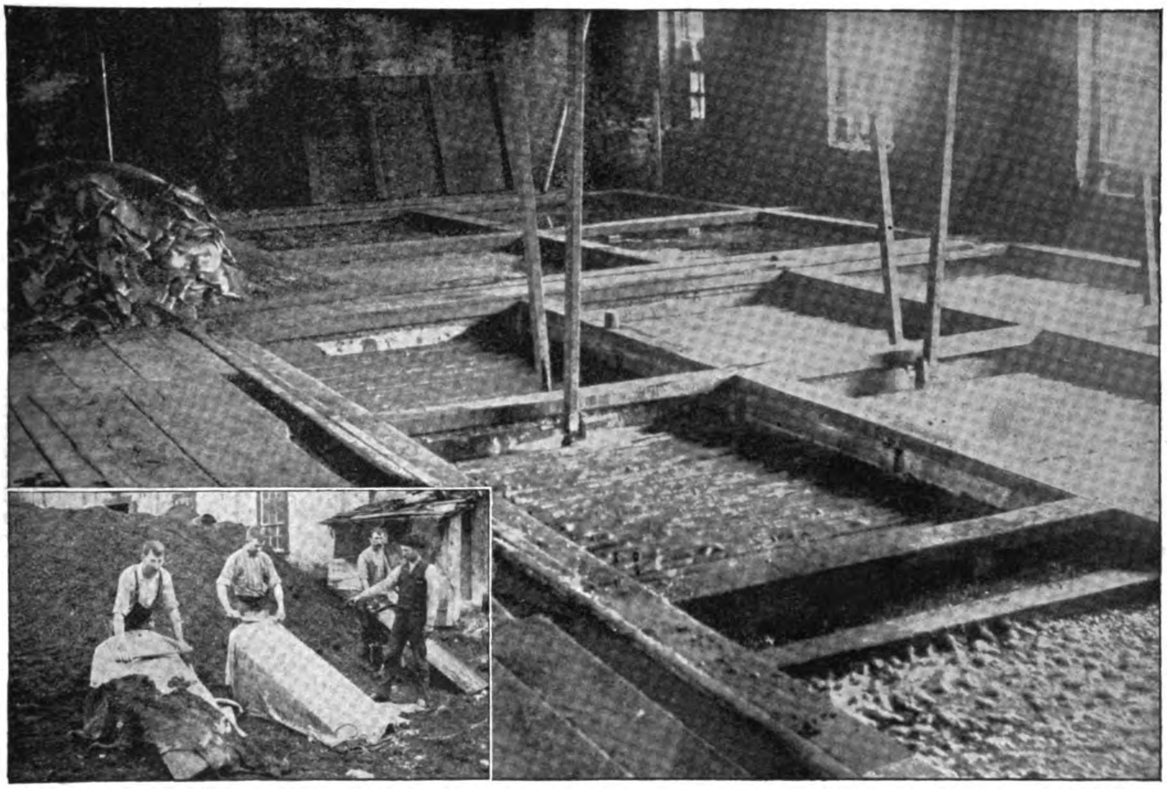
Very strange and erroneous ideas prevail among those who use leather, and have no knowledge of the art of tanning; certainly it is an art, and one of the oldest handed down to us. The general opinion prevails that leather made in "ye olden time" is superior to ours of the present time, but such is not the case; in fact, the fundamental process of tanning to-day is precisely the same as that of a thousand years ago, except that we enjoy improved machinery and appliances which further the process and improve the material. What took our forefathers from fourteen months to about two years, we accomplish in from four to six months, and the quality of leather is as good, if not superior to the leather made a hundred years ago; with the aid of steam and power we can facilitate the process and shorten the length of time to produce the leather. The "olden time tanneries" had the lay-away vats in the yard exposed to the elements, and in rainy and inclement weather, as well as during the winter, the tanners could not do any work, and left the leather lying in the vats, generally to the detriment of the stock. In our present improved and model tanneries everything is done under cover, even the bark is put under sheds to keep it dry, and good leather is tanned within four months; however, belt and prime harness leather generally takes six months.

When the leather is taken from the last layer of bark, it is oiled on the grain and hung up in a darkened room to dry; to obtain a nice clear russet color the place must be kept at an even temperature, and very little heat used. After the leather is thoroughly dried it is put up in rolls containing five butts (hides) each, and whenever a carload is ready it is shipped to New York; here it is again examined and weighed, and all butts not suited for belting are thrown out and finished into sole leather for shoe purposes.

The perfect hides for belting are soaked in warm water, and the centre part cut out and used for prime belting; the waste or offal is finished and rolled for shoe purposes. When the pieces are thoroughly scoured and cleansed they are oiled on the grain and hung up to dry, and when in a semi-dry condition, they receive a coat of stuffing made of equal parts of cod oil and beef tallow. This is done to preserve the leather and make it pliable for the transmission of power. After the stuffing has entered the pores, which takes about twenty-four hours, the leather is subjected to great strain in large stretching machines; great care and good judgment must be manifested in this part of the process. Each piece of leather must receive an equalizing strain because of the peculiar formation of the hide, the fibres being very fine and closely knit together on the back of the animal, and running coarser and thicker towards the flanks. It is of the highest importance, for belts intended for electric light plants, to have an equal tension over the entire surface of the belt; therefore, the stretching process of belt leather needs the utmost care, and should receive the closest attention. After the pieces of leather are thoroughly stretched, they are worked smooth on the grain side, and both by hand and machine labor are set down as solid and compact as possible; then they are put into a drying room and thoroughly dried. Afterwards one edge of the pieces is straightened, and they are then cut into whatever width of belt they are best suited for; the pieces of each width are matched accurately as to thickness, and then the laps (joints) are cut by a machine, the edge of the laps are feathered, and the joints cemented (glued) together, and pressed under a hydraulic press, which pressure is considered the best by all first-class belt makers.

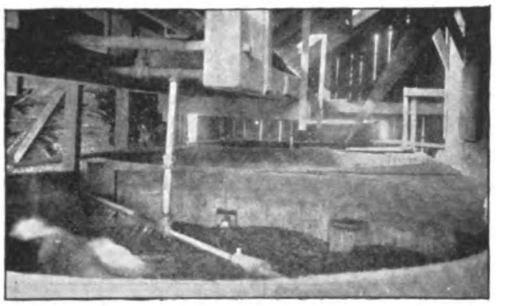
Rivets are now rarely put into belts; a double belt well cemented is good for all ordinary purposes, and rivets are superfluous; however, certain fastenings, such as endless copper wire screws, which do not obstruct the surface or unnecessarily stiffen the belt, are a benefit; especially when the belt comes in contact with water or too much oil, this fastening prevents the belt from coming apart, and holds the leather firmly together.

All main driving belts over forty inches in width have to be



HANDLERS AND FLESHING HIDES.

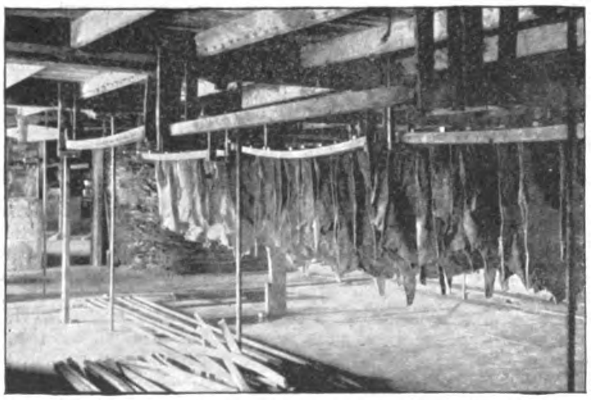
made in sections, consisting of two or more pieces of leather cemented together; the average hide for belting does not contain more than forty inches in width of solid leather suited for belting, very rarely over that; therefore, wide main belts are made in sections. Ordinarily the pieces are not lapped parallel, but simply butted. For example: A sixty-inch double belt receives two thirty-inch pieces for the first layer, laid side by side, and a thirty-inch piece over the centre of the two lower pieces to break the joint, and two fifteen-inch pieces on top of each edge of the lower layer to complete the width; thus the belt is cemented together.



Leeching Bark.

However, for electric light plants where belts are run at high speed and with variable power (which produces sudden strain), the seam of these butted joint belts, in several instances, broke, doubled up and destroyed the belts completely. To guard against such a calamity it is considered advisable to make wide main driving belts with parallel joints. For example: A sixty-inch double belt will be made of two thirty-three-inch pieces joined parallel, with a three-inch lap, making one solid piece sixty inches in width, and on the upper part put a thirty-three inch piece in the centre, and two eighteen-inch pieces on the edges, all joined with parallel laps; this cemented together will make a sixty-inch double belt with unbroken surface, and as one solid piece of leather having a uniform tension and able to withstand an equal strain over the belt transversely as well as parallel, and thus will prevent such large, heavy driving belts from collapsing at the parallel joints. Every one must admit that main belts made on this plan are superior, and more reliable, and would come into general use if it were not for the additional cost of labor and material in making them.

Leather being by nature an absorber of moisture, belts must be guarded against exposure to oil. In electric light and power plants much mineral oil is used, and the great velocity at which the belts are run seems almost imperceptibly to suck or draw the oil from the journals of the engines and dynamos, and allow it to be absorbed by the belts, which get completely saturated with oil. This in a short time rots and destroys the fibre of the leather. Various methods have been used to overcome this difficulty. One of the most successful is a certain composition or belt dressing which is rubbed over the surface of the belt, and closes the pores of the leather. No foreign substance can penetrate a belt treated with this compound, and the belts last much longer and give better service. With perforated belts this compound does not seem to be so effectual, because the perforations naturally expose the inner part or the heart of the leather, which is very porous; however, the surface of the belt being covered it shields that part of the leather which comes in contact with the pulleys, and the current of air passing through the perforations protects the belt to a certain extent, and that class of belt runs smoother, with less friction and is more reliable.



Drying Loft.

And now, gentlemen, we have reached the point where another curious and erroneous idea prevails among many engineers, namely, that belting should be made of pieces only four feet in length; as if all hides were of the same length and texture; it will surprise these men to learn that there are no two hides alike, they vary in some particular point. Hides exist which will make almost six feet of sound solid leather below the shoulder, and again some hides will not make four feet of solid length; the only safeguard is to specify belting made of leather cut below the shoulder of the hide, irrespective of length.

Now, gentlemen, I have endeavored to show you, in this paper the various processes and changes to which a hide is subjected in its travels from the "Tannery to the Dynamo."

HOW TO FIRE A BOILER.[1]

BY R. HAMMOND.

It has been said that the waste of fuel due to improper firing is often of more consequence than any other loss which is produced in the operation of a steam plant, but in a great many cases the waste of fuel cannot be entirely charged to improper firing, as there are other causes by which a waste of the evaporating power of the fuel is produced. The principal of these are: First, the improper construction of the boiler in relation to grate surface, tube area, heating surface and combustion chambers; unless these proportions are properly worked out, it matters little whether the firing be done by mechanical means or by the more intelligent fireman, waste of fuel must necessarily follow.

A great many contrivances have been placed on the market, such as mechanical strokers and other means by which coal and air can be supplied to the furnaces of steam boilers for the purpose of obtaining good combustion without producing a waste of heat by allowing too much air to pass above the grates or an insufficient supply below the grates; by this statement I do not mean that any particular method of firing will produce any more heat from a pound of coal than Nature put into it; just as good results can be obtained from hand firing as have been obtained by the best mechanical means.

It is often the case that firemen are paid insufficient wages for the work they are expected to do. We should be as particular to have good firemen in charge of our boilers as we are in having good engineers in charge of our engines; a good fireman should be just as capable of manipulating the furnaces of his boiler so that his steam recorder and his coal and water records will show just as good cards as the engineer can show in the manipulation of the steam he uses in his engine. If we paid the same attention to all the details of the construction and setting of our boilers and their economical use of fuel as we do to our engines our steam plants would be far more economical; everything is "*shined up*" about the engine. Engineers go into all the details of its construction and management and the greatest care is taken in the figuring out of its proportions so that it will have the very highest possible initial steam pressure and temperature and the very lowest possible terminal temperature and pressure; all endeavoring to get the greatest horse power from the pound of coal, thus securing the greatest economy. These very same highly educated individuals, who designed these engines, forget that all the power comes from the pound of coal and pay little attention to how that power is transmitted from the coal pile to the engine. It is just as essential to good economy that the boilers should have the very highest initial or furnace temperature, and the highest possible steam pressure, and the lowest possible chimney temperature, as it is for the engine to be economical under similar conditions of high initial pressure and temperature and low terminal temperature.

Experiment has proved that bituminous coal requires 150 cubic feet of air per pound of coal for good combustion; an excess of air results in a waste of heat which it carries into the flues and chimney and often a greater loss in an insufficient supply to produce good combustion.

In my experience for steam plant boilers carrying 80 to 160 lbs. of steam, I find that at least 20 lbs. of bituminous coal should be burned per square foot of grate per hour, and the air spaces of the grates should not be less than 50 per cent. of the grate area, and the draft pressure not less than one-half inch of water; if the grate surface is so large that only 10 lbs. of coal is consumed, it would be more economical to reduce the grate surface and burn not less than 20 lbs. with good draft, thus securing a good combustion. The same weight of coal burned on a large grate would not be as economical on account of the low temperature; the temperature of the furnaces should not be less than 3,500 degrees, and the ratio of the draft area through the tubes or flues should not be less than one-sixth, nor more than one-fourth, of the grate surface, and the proportion of heat surface to grate surface should be at least as 35 to 1.

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[1] Read before the National Electric Light Association, Buffalo, Feb. 25, 1892.

Under the conditions just stated, boilers should be fired very economically whether done by mechanical means or by hand. I have noticed in firing marine boilers on the great lakes that the firemen spread their coal evenly over the entire grate at each firing, and they produce steam very economically, while firemen on coastwise steamers will pile up the coal just inside the furnace door and as it becomes coked will rake it back over the incandescent fire and grate with equally as good but no better results in the way of economy than obtained by the lake firemen; both of these ways of firing are equally good, but in all cases the grate bars should be entirely covered, and the amount of air required above the grate should be admitted from above instead of below the grate.

Different grades of bituminous coal require different methods of firing, and by a little experiment the experienced fireman soon finds out and adopts the best method of firing, and in all cases he should keep his flues and tubes clear of ashes and soot, as well as his fires and grate bars. In firing anthracite coal, the coal must be spread evenly over the grate in all cases, and like bituminous coal must be burned at a high temperature with good draft.

Steam users should see to it that all parts of their boilers and settings should be of equally as good proportions for strength and economy as their engines; employ good, intelligent firemen as well as engineers, and see that both produce good indicator cards. By a little attention in this direction steam users will themselves soon become experienced firemen and engineers and can readily tell whether the firemen and engineers are doing their duty.

THE CONSTRUCTION, SAFETY AND OPERATION OF SWITCHBOARDS.[1]

BY M. C. SULLIVAN.

THE manager, who has seen his station grow from a mole hill to a mountain, who has been compelled to add on dynamo after dynamo to satisfy the demands of the maddening crowd, now has a problem on his hands to equip a switchboard that will not only handle the service of the present time, but what is in store in the future. He knows from experience that what may be called the "skeleton board" with spring-jack connections, will not suffice for this, and he must look about for another method. In thus casting about for the proper assistance, the manager is unfortunately thrown upon his own resources. A great source of the trouble are the cables, or flexible conductors, used for making the cross-connections from one part of the board to the other. While we may exhaust every means to make the operator safe from contact, the use of these cables cannot very well be eliminated. It is possible, however, to construct a board on which any combination can be made without cables, but it would be so large and cumbersome as to become practically inoperative, in fact would be a very complicated affair. It is nevertheless practical to equip a board for arc service so that every part of the live circuit would be entirely insulated from the front. For large composite stations, embracing arc and incandescent lighting, of both high and low tension, and power generators for street railways, condensation is one of the vital features, not in the sense of crowding anything, but of utilizing every inch of space to install the apparatus necessary to do the work required. A most effective way to build a switchboard for stations of this character is to have it arranged in the form of a square so that one side could be devoted to each division of the service.

Stations occupying a large open floor with high ceiling present the opportunity for building the ideal switchboard. This could be raised above the floor a sufficient distance so as not to occupy any valuable floor space. For this matter it might be suspended from the ceiling. The wires from the dynamos could run directly to the left, thence through the switchboard, and from the latter to the cupola, arranged as nearly over the switchboard as possible. This arrangement would give us a central starting point for our lines, enabling us at once to trace every wire of the system. However desirable such an arrangement as the above may be, the conditions are such that we cannot always do as our best judgment dictates, but rather have to make the best of things as we find them.

The prime object to be secured in switchboards for high-tension service is safety, not only to the attendants, but to the station. This can be accomplished by having every part of the board over which current is transmitted insulated in such a manner that contact from the front is impossible.

The prime necessity of switchboards in railway power stations is facility for rapid manipulation whereby any part of it can be reached in the shortest space of time. Here also the indicating instruments must be within plain sight so that the movement of the current, with its rapid vibrations, can be readily noted.

We now come to the most important feature of the whole question; what material should be used for our switchboards? As it must be fireproof, the use of wood is entirely prohibited. We must therefore look for something entirely different. Various efforts have been made to make wood fireproof. This has been accomplished to a limited degree, but the element of doubt still remained. Slate, as many of you know, is the best thing that Nature has yet offered us. For strength, lightness and insulation it is the only material in sight. Unfortunately, however, slate is an alluvial deposit of a laminated character and often contains metallic substances which destroy its insulation, making short circuits and other disagreeable elements. When in the rough stone it is hygroscopic to a considerable extent, and when it becomes saturated with moisture makes surface leakage possible. Great care should be consequently exercised in selecting slate for switchboards, and only that which possesses absolutely no metallic properties be used. This can be determined by the well-known rules of electrical testing.

The drawbacks met with in slate have determined some manufacturers in using marble for this work. This has only one-fifth the breaking strain of slate, and where it is used in the place of slate this must be taken into account. Marble presents the same hygroscopic elements as slate, and there is some metal in it, but owing to its peculiar formation, this metallic substance is not present in any great quantities as it is between the laminations in slate.

Iron should be used for the framework of all switchboards, and in the case of high-tension circuits a wire should be run from this framework to the ground, which is entirely insulated from the circuit, so as to prevent the board from becoming charged and discharging through a person who happens to be near by. Complete plans and specifications should be perfected, so that when an order is given to the manufacturer to make a board, you will know whether it is his fault or your own if things do not turn out as you desire. This may require more time and attention than you wish to give this branch, but if you have experienced the inconvenience some people have suffered, you will feel very much different.

MUNICIPAL FRANCHISES FOR QUASI-PUBLIC CORPORATIONS.[1]

BY ALLEN R. FOOTE.

I BELIEVE that an American economic system is as necessary to American industrial independence as was or is, an American political system to American political independence. The particular feature of foreign economic systems to which objection may be incidentally made in this paper, is State or municipal ownership of industries. Those who advocate such a policy in this country are wrongly educated foreign socialists and college professors who have been educated abroad.

A franchise is the title deed upon which quasi-public corporations are founded. A perfect franchise should legally contain every provision that is essential in a deed to real estate, every provision that is required to establish the rights of property, every provision that maintains the rights of free labor.

The production, transmission, subdivision and cost of mechanical power determines the number of persons who can use such power *with a profit*. The number of persons such users of power are able to employ with a profit, determines the number who can enjoy *the rate of wages* the utilization of mechanical power enables such employers to pay. Cost of power is the determining factor. The lower this cost, the better the opportunity for making a profit. The more certain a profit becomes, the greater will be the number of persons employed. The larger the number of persons employed, the smaller will be the number of the unemployed. The smaller the number of the unemployed, the better will be the wages of the employed, and the smaller the tax on the employed for the support of the unemployed, the greater will be *the profit of labor*. The greater the profit of labor, the greater is the prosperity of individuals, municipalities, States and nations. While every person has a vital interest in the settlement of questions affecting industrial prosperity properly to secure the greatest economic advantage, those most interested are the wage-workers and the unemployed.

Properly to supply these needs, it is necessary to create quasi-public corporations, and grant to them franchises giving them the right to construct, maintain and operate the necessary works, and to construct, maintain and operate through the streets and alleys, the necessary street and service connections to enable the service to be supplied to every building in the municipality. The importance of the organization and facilities granted to such corporations will be quickly appreciated if any citizen will ask himself what the industrial, commercial and social advantage to his municipality would be if it were true that all these services were there rendered at a less cost to the user than in any other municipality in the world. No one will have to think long or closely on the subject to become overwhelmed with his conception of the vast magnitude of the value of such advantages. How properly to secure such advantages is a question requiring clear perception, broad views and an entire absence of prejudice, or interests that tend to sway the compass needle by so much as a hair's breadth from the true point of direction, and a calm, unyielding judgment. Men so dishonest as to be willing to divert, by force of legal enactment, a portion of the profits of industry from those who incurred to those who have not incurred a risk in their production; men so incapable of a correct judgment as to denounce rent, interest and profits as robbery; men so prejudiced against monopolies that they regard them with fear and hatred; men so full of sympathy with the sufferings of the poor that they are blind to the cause of their sufferings, are not safe guides for public opinion.

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[1] Abstract of a paper read before the N. E. L. A., Feb. 25, 1892.

[1] Abstract of a paper read before the National Electric Light Association, Buffalo, February 25, 1892.

A means of producing light, heat and power for public and private use, distributed from a central station, is a perpetual municipal need. The best interests of its users demand that such means shall be abundant, wholesome, reliable and safe, and that it shall be furnished at the lowest possible price. That these requirements may be properly satisfied, true economic conditions demand:—

First. That a corporation organized to supply a perpetual municipal need shall have the exclusive right to perform the service perpetually.

Second. That the service shall always be supplied by the best methods known to science that are made commercially available by the best practices known in the art.

Third. That all accounts shall be honestly and correctly kept, that economic thrift be insisted upon in every department and that charges be so fixed from time to time, by a competent and disinterested tribunal, as to yield a revenue sufficient to pay all fixed charges, expenses of administration, operation and maintenance, and a reasonable per cent. dividend annually upon the investment.

A comparison of these economic conditions with the conditions fixed by the laws on this subject in all States will quickly show how blindly the blind have been led in efforts to secure the greatest good for the users of the services supplied by municipal franchise corporations. Had laws governing the organization, management, and control of municipal franchise corporations been enacted in accordance with the requirements of true economic conditions, instead of in compliance with the dictates of an unintelligent self-interest or prejudice, how great the change in their wording and meaning would be. There would have been no reference to a particular source, force or instrument, such as gas, telegraphs, telephones, electricity or horses. *The character of the need to be supplied, not the character of the method of supplying it, would have determined the designation of the work to be done.* The sovereign law of labor and property would have protected the right to work.

So rapid and so radical have been the industrial changes wrought by a growing intelligence, encouraged by the acknowledged freedom and dignity of labor, facilitated by the right of private initiative, driven by the energy of hope, inspired by the certainty of owning the profit for the risk incurred, that in a single decade the methods in use at its commencement become obsolete before its close. As a result, the strongest barriers to progress that now exist are the limitations placed on municipal franchise corporations by legal specifications defining the methods to be employed instead of the character of the need to be supplied. The wisdom of the Fathers was not equal to our own. All such barriers must be brushed away.

What would be thought of persons who would undertake to secure improvements for a city in the form of buildings of the largest dimensions, employing the most durable material and the best style of architecture, by offering a title to real estate on which the buildings were to stand, that did not guarantee exclusive possession, and perpetual tenure? The moral and economic sense of the community would be shocked by such a proposal. Yet there are persons in every community who will contend that works costing more than the best buildings in the city which, if operated under true economic conditions, will inevitably enhance the value of all inter-municipal real estate more surely than any other factor of modern civilization, shall have no better title than the one indicated.

How supremely ludicrous a city council would appear that should vote that a street railroad company might use horses to draw its cars but should not use the best horses it could buy. How strange it would seem if a State Legislature should enact a law that a company might generate and distribute gas for the purposes of light, heat and power, but that it should not adopt the best gas-making methods. These things are all as consistent as laws providing for the supplying of municipal needs by mentioning the methods to be used and thus limiting municipal franchise corporations to the use of the methods named, instead of requiring them to adopt the best known methods at the time of incorporation or that may thereafter become known. How strange it appears in the light of the requirements of true economic science that municipalities have supposed they could obtain a supply for a perpetual need, requiring expensive plants, conductors through all streets, service connections to make the supply available in every building, and have the service wholesome, reliable, safe and rendered at the lowest possible price, in the way in which they have undertaken to secure these advantages. They have limited the right to do business to a comparatively short term of years. They have allowed others to build, as it were, on the same piece of real estate. They have limited the methods to be used, so that, when the discoveries of science and invention have made better methods available, existing corporations could not use them, thus compelling the organization of other corporations and a duplication of plants. They have created unnecessary uncertainties by limiting the contract for public service at a fixed price to one, five or ten years, instead of making the contract perpetual and the price adjustable so that it shall always bear a fixed relation to the cost of production.

The services rendered by municipal franchise corporations are assistance to industry, promoters of comfort and inducers of prosperity. Any unnatural restriction placed on them is as fatal to the welfare of society, as an unnatural obstruction to the inhaling of air or taking of food is to the health of the physical body. Any tax levied upon them is as fatal to the best interests of industry, as the extraction of blood is to the physical strength.

A consideration of vital importance to wage-workers, in the discussion of a question of this kind, that cannot be urged upon their attention with too much force, is the fact that every time an industry is removed by legislative enactment from the list of profit-producing industries and placed in the list of non-profit-producing industries operated under government ownership, an avenue to industrial independence is closed. Profit-producing industries are avenues to industrial independence and economic freedom for all who are engaged in them. For the wage-workers, more than any others, the self-interest of the individual, the moral interest of society, the group interest of the municipality, State, and nation, demand that *all avenues to industrial independence and economic freedom shall be kept open.*

PROCEEDINGS OF THE FIFTEENTH, ANNUAL, MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

FEBR. 23, 1892.—MORNING SESSION.

THE meeting was opened by PRESIDENT HUNTLEY, who introduced Mayor Bishop, of Buffalo, and who welcomed the Association to the city.

PRESIDENT HUNTLEY then delivered the following address:

PRESIDENT HUNTLEY'S ADDRESS.

In behalf of the National Electric Light Association I am glad to welcome to our meeting to-day those who represent the city and public of Buffalo, and as a citizen of Buffalo and president of this body, I am not less happy in adding my own welcome to those which greet the visit of the Association to this, the Queen City of the Lakes, a city far enough West to have all the bustle and energy of Chicago, but still far enough East to exhibit the dignity and solidity of New York.

As becomes one who fills this chair, there are certain topics of immediate interest and importance that I will venture to call your attention to, and if I do not touch all the questions that affect our great industry, it is because I made allusion to them at Montreal last September, or expect that you will get enough of them before you go home.

The meeting of this Association so near to Niagara seems to afford a fitting opportunity for discussion of the problem which is attaining great importance day by day, namely, the electrical transmission of power. Whether we are engaged in the distribution of electric light by arc or incandescent lamps, or in generating current for stationary or railway motors, or for heating, we are essentially engaged in generating, distributing and converting power into its various forms; hence any method by which the initial power can be obtained in a manner or from a source of greater economy, deserves our most serious consideration.

The question may, therefore, naturally be asked: What would be the effect of the utilization of Niagara or other large water powers, so far as concerning outlying cities? How far will it be possible to transmit this power, not theoretically, or in an experimental way, but commercially, so as to insure a fair dividend to the investor? At what point does it become cheaper to carry current than to carry coal? Now these are large questions. They are, in fact, the largest problems in modern engineering. When you come to deal with such an immense and incalculable source of power as Niagara, our previous plans and methods and successes sink into nothing, as indicative of final results and realizations. Our attitude toward such a taming of Nature is very much the same as that of the first electrical experimenters when they interrogated her with the help of pith balls and little chips of amber. Even the late demonstration at Frankfort teaches us little, for there we had the utilization of only such a water power as a well to-do American citizen puts in his back yard for ornamental purposes; and the experiment was tried in summer time, when winds are light and skies are clear. Moreover, that plant was run as an exhibition, with the Emperor of Germany and other dignitaries lending a patriotic hand and subscribing patriotic dollars. Now, gentlemen, when you and I who operate stations come to use such water powers, or distant coal beds, we shall not be able to fall back on kindly emperors for timely donations. Some of our fellow-citizens will be be quite ready to help us, but with the instinct that is born in every American, they will want the dollar they pay out to bring another back with it.

Our field of work, in short, with its newness and rawness, is one in which experience must always moderate enthusiasm To me perhaps more than to many of my fellow members, this question of long-distance power transmission is fraught with large possibilities and grave responsibilities. It is imperative that I should know the truth and the facts; and if ever the time comes when I can be humbly instrumental in giving Buffalo a sparkling midnight firmament created by yonder Falls, I shall ask no grander task. I have ventured to make this momentous subject one of the leading topics here, and my call for information has been responded to by some of the most authoritative workers and thinkers in this direction. To them I shall leave the exposition of its details, with the conviction that you will forgive me, if under a sense of duty, I have indicated the practical limitations that must govern every man of affairs.

In this connection I cannot help pointing out again that after all, the cost of coal to operate an electric plant is only one among many items, and frequently a small percentage of the total cost at that. For instance, in electric railway work, the cost of coal comes to about 10 per cent. of the total operating expenses, while in electric lighting it does not probably exceed from 15 to 20 per cent. In these days when municipal plants are the subject of frequent discussion, these facts are generally lost sight of, and the cost of electric lights is calculated by reference to the amount of coal burned under the boiler; thus ignoring the fact that firemen, engineers, linemen, trimmers, etc., are required; that carbons require daily renewal, and globes break; that, like all other machinery, engines, boilers, dynamos and lamps are subject to depreciation, require repairs, that the building must be insured, and that a sinking fund must be established for renewals.

Cheap power in itself would therefore influence the cost of electric lighting very little, even if the electric current is distributed in the immediate vicinity where it is generated; while, its distribution to any considerable distance in large power units on a commercial basis seems to be awaiting its demonstration here rather than in Europe. Hence I would recommend a study of the facts pointed out, which ought to make any community falter before investing in a municipal plant simply because it may happen to have what is supposed to be a cheap source of power around the corner.

Municipal ownership is, as I have just intimated, a topic that some of you have to deal with directly. This Association has always been a forum to which new ideas in the industry might be brought, and our efforts have done not a little in clearing away the haze and confusion on the subject of municipal control and operation. I have made a special effort, as evidence of our impartiality, to get together at this meeting some of those who believe in the abolition of private enterprise and in the surrender of all the ideas that make us crave for a home of our own and the accumulation of a few dollars for a rainy day. If we are wrong in the opinion that self-help is the best help and that ten well-to-do citizens count more for the community than twenty superfluous officeholders, it is time we knew it. Some people want the Government to run the railroads and some want it to buy up the telegraphs and telephones. Others want the municipalities to own street railways, gas works and electric light plants. In Boston there is, I am told, a demand that the city shall collect more taxes and put it into public coal yards. I am reminded of my reading as a boy at school, when I learned that the foredoomed population of a great city once sent up a howl for free bread and free tickets to the circus. Now, let me say right here that public franchises are a public trust. In return for them we are to do something or agree to do something that the community wants. In my humble judgment it has yet to be proved that such a way of introducing improvements and benefits is wrong or foolish. I am a busy man, and have been earning a livelihood all my life, but I have had time enough to observe that the whole vast industrial development that has added so enormously to the comfort and happiness of life has come from the investment, under public franchises, of private capital, skill and enterprise. The public has thus been made the partner in all the great works of the age, and has thus gained infinitely more than it could have secured if it had raised an equal amount of money by taxation, and had placed the proceeds in the hands of a vast body of officeholders for the same purposes.

Among the questions that interest us are those that concern the relations between the so-called parent companies and ourselves, the local companies, operating the apparatus that the parent companies sell. I am aware that in some quarters the consolidations that have been effected from time to time are viewed with anxiety, and that in others the cry of bad faith has been raised—not, perhaps, without warrant. But consolidations have their hopeful, better side. At one period our respective territories were practically open ground for thirty or forty competing manufacturers, each of whom had the best system in existence. That fierce and wasteful local competitions should be engendered under such conditions was inevitable, and even to-day the industry is hampered by the central stations that came into being under this unwholesome outside stimulus. We were, I might say, peaceful farmers whose early and promising crops were an invitation to every raider that could reach us. But at the present time the situation is clearing. The various consolidations let us see pretty clearly with whom we were dealing and we know, too, something of the value of the claims made for the apparatus or the patents that protect it. We have also learned that much apparatus essential to good work is free from patent royalties, and that the moment prices go beyond the point of paying a fair manufacturer's profit, a dozen big engineering firms are ready to invest with capital and brains. My esteemed friend and predecessor, Mr. Weeks, has even suggested that we should combine and manufacture for ourselves. But there is no need for that. Dynamo and lamp construction has made a place for itself already as one of the arts, very few fundamental patents are left, and every day brings us nearer to the time when generator building will be as universally practised as engine building.

Meantime, we who run the stations have been learning hard lessons in the school of experience, and that training is as valuable a part of our enterprises as are the franchises under which we have been induced to put our savings into the business of supplying light and power to our fellow-citizens. Unfortunately much of that experience remains a sealed book, and it is with the view of exchanging practical ideas that this Association carries on its work. I never meet one of my fellow-workers in this field but he teaches me something; possibly I give him a little in return. Now, apply that principle on a broad scale, and see how beneficial it must be to find out from each of two or three hundred earnest men their best way of doing things. That means progress, prosperity, perfection. But as long as only a few of us get together; as long as a feeling of apathy is allowed to control, our central station practice will fall far short of what it ought to be; it will not be as near standardization as it should be; and we will not make as much money as we ought. My political and social economy teaches me that the greater profit I can get out of any enterprise, with fair service and due satisfaction to the public, the better citizen I am. The rewards of society are for those who can increase its wealth and raise its degree of comfort and convenience. Now, the central station man who stays home is not doing his share to promote economical operation. I will go so far as to state that if once a year half the central stations of the country were represented in our gatherings, the average dividends would be increased, while not a few stations that now struggle on in dreary debt would reach a basis of solvency. I am very thoroughly in favor of one meeting a year for this Association, and of a systematic, energetic effort to get everybody there. Every member should make it his business to interest his neighbors in the work we are doing, especially the smaller stations.

As an inducement to the smaller stations I would be glad to see the dues somewhat reduced so that they can come in without feeling that they are paying dearly for their whistle. There is no valid reason why the dues should be high, and if cutting them down will bring in the stations most to be benefited, no hesitation should be felt in taking such action. I would like to see our membership ten times larger. As it is, the influence of the Association is by no means insignificant; but with larger membership its deliberations would be so much more valuable, and when it approved or disapproved, the matter would be at once settled for the entire industry.

It is important that we should interest ourselves in the World's Fair. I surely do not exaggerate when I say that every patriotic New Yorker wishes Chicago the biggest kind of success in her great undertaking, and admires the genuine American fashion in which the Western metropolis has sailed in to win. It is not only our duty, but it will be a source of great pleasure to contribute to the importance and success of the Exposition. We ought to meet in Chicago next year. We must go there in a body. The Chicago Electric Club is ready to take care of us, the whole city has a welcome for us, and the electric exhibit will be the finest the world has ever seen.

We have a good programme of papers for this Convention, and I ask you to do the authors the compliment of discussing them exhaustively. If you don't agree with them, tell us why. If you have any local problem, take us into your confidence. You will probably find that others here have laid awake nights worrying over the same matters, and have sometimes found a way out. If you have made some improvement in station practice and operation, ask for the floor; and if it is too good for everybody, we will go into executive session over it. In these and other ways, you will strengthen the hands of the chair, promote the cause we are here to advocate, and make this meeting the best we have ever had.

An invitation was then read from the Delaney Forge and Iron Co. to go through their works. The Postal Telegraph Co. offered the use of their facilities for the delegates to send social messages free. Free use of all telephone wires in the city and also of the Long Distance telephone wires to New York and elsewhere were offered. The California Electrical Society sent a pressing invitation to hold the next convention in San Francisco. Referred to the executive committee.

A committee of three was appointed to draft resolutions of regret respecting the death of Mr. George Worthington, one of the organizers of the Association.

The Report of the Committee on Underground Conduits and Conductors was then read by MR. M. J. FRANCISCO, as follows:

REPORT OF COMMITTEE ON UNDERGROUND CONDUITS AND WIRES.

At the Providence meeting of the Association, a committee was appointed to investigate underground conduits and conductors, and collect data regarding their working. The committee, in carrying out this work decided to send out circulars to all central stations and other parties using underground conduits, asking for information regarding its use and the success obtained. The following circular was printed and mailed:

A committe was appointed at the Annual Convention of the National Electric Light Association, held in Providence, Feb., 1891, to investigate and collect data relating to underground conduits and conductors. In order to secure the full facts, answers to the following questions are desired. Will you kindly answer and return as soon as possible?

1. Mileage of conduit laid? 2. Cost of conduit per mile? 3. Mileage of conduit in use? 4. Mileage of duct laid? 5. Mileage of duct in use? 6. Average hours per diem same is operated? 7. Number of manholes? 8. Cost of manholes? 9. Number of hand-holes? 10. Cost of hand-holes? 11. Number of services taken direct from conduit? 12. Cost of maintenance per mile per month? 13. Cost of repairs per mile per month? 14. Average number of burn-outs and grounds per mile and the cause? 15. Have you found the working of your underground system a commercial success? 16. What is the voltage on each conductor? 17. What is the current, in amperes, carried by each conductor? 18. What is the size of the conductors used? (In answering this question give the number and gauge.) 19. What is the thickness of the insulation? 20. Who is the maker of the cables? 21. Are the cables laid in any form of conduit? 22. If so, what kind of conduit is used? 23. Have the cables worked satisfactorily during the entire time of their use? 24. If the cables have failed to work satisfactorily, to what cause do you attribute the difficulty? (Please answer as fully as possible) 25. Have you abandoned any conduits because they proved failures?

The names of companies or stations will not be made public, but grouped by numbers. We wish this information for the benefit of every member of the National Electric Light Association.

It soon became apparent to the committee that they were treading upon very dangerous ground, nearly every man addressed at once concluding that there was a direct drive being made at him or his business, and the amount of ignorance displayed by parties who had used underground cable, and were supposed to know of its value and practical working, was rather alarming. Then a plan was adopted to secure from the manufacturers a list of parties who had purchased underground cable with the intention of making personal examination of each plant. Here again the discovery was made that, with a few exceptions, the manufacturers did not know to whom they had sold underground cable and were unable to furnish the list. After these plans had failed, it was decided to investigate personally various plans and systems in use, and the chairman of the committee started out on a voyage of discovery.

The committee found that what had answered the purpose in one city had proved a failure in another, owing to local troubles, such as the nature of the soil, gas, steam, and in some cases politics, which had a very peculiar effect upon the conduit itself, as well as the insulalation used, and, in one city, we found that a liquid insulation, passed through the conduit in such a way that the officials could personally examine and test its efficiency and quality, was the only conduit or system they would approve or adopt.

In another city, the central station company placed about ten miles of underground conductor for an arc line, passing the same through an iron pipe, relying upon the insulation of the wire; it utterly failed and they took it out. They then tried another make of wire, drawing it into that same iron pipe; this held for a short time and then began to burn out, and sometimes two feet of the wire would be entirely burned out, and when it was drawn out of the pipe you could blow dry powder in clouds from the pipe, showing that it was not moisture that caused the trouble. Another company tried a conduit made of three-inch tarred planks, using underground cable with $\frac{5}{32}$-inch insulation that was supposed to be first class; through this they passed a 1,000 volt current. As soon as they started they had innumerable burn-outs, grounds and crosses, and finally abandoned it.

One company, using 1,100 volts and 50 amperes, tried passing a cable through pump logs, with wire of $\frac{1}{16}$-inch insulation and were troubled with grounds and burn-outs, and found the insulation was too thin and had to be abandoned. Another company tried conduit made of asphalt, with several makes of wire, using 1,500 volts and ten amperes, but it did not work successfully on account of burn-outs, grounds and crosses, and they abandoned the entire outfit.

In the course of this voyage, a gang of men were discovered trying to locate a burn-out; as this was directly in line with our business, we decided to anchor and devote sufficient time to the case for an examination. The plan adopted was to dig up the pavement and disconnect the iron pipe containing the wires and then test in each direction; this was repeated until fifteen openings had been made in the street at various points and the section burned out discovered, and it was found that, not only had the wires been burned off, but the iron pipe for nearly two feet had been melted, destroying the whole line. This pipe was removed and a new one inserted and connected.

Of course, in many cities where concrete or asphalt pavements were used, it would be impossible to obtain permission to tear up the street in fifteen places to replace one burn-out, to say nothing about the expense. There were five men employed upon this line, and they informed us that their entire time was spent in tracing and repairing burn-outs in their beat, covering about two wards.

In a municipal plant of one city, where the Dorsett system was used, also iron pipe with cement lining and other styles of conduit, it was stated the underground conduit was perfection and could not be improved upon. A little private investigation developed the fact that one underground circuit had been in trouble for six months previous to our visit, and at that time the trouble had not been located; also that the voltage of the lamps varied from 25 to 55 volts; but as it costs nothing to run a municipal plant, this condition of lines and lamps was not considered of any importance.

Various plans were tried for lighting the Hoosac Tunnel. They used 1,000 volts, but the insulation was too thin and would not stand and they had constant trouble, as the tunnel is very wet and in many places the wire was covered with water. They then tried another style of wire, using 1,000 volts, alternating current, lamps in series, twenty in each set, 1,250 lamps in all; since this plan was adopted they have had no trouble, and the same wire has been in use three years, running twenty-four hours per day.

The Electrical Bureau of Philadelphia have about fifteen miles of duct in use for electric lights; they are using 2,500 volts and $9\frac{6}{10}$ amperes. They report six grounds from January 1, 1890, to November 13, 1891, and all, except one, from too thin insulation. In one case the cable was damaged before drawing into the duct. They used the creosoted wood conduit; the cost of this kind of conduit is about $4,500 per mile, including manholes. As they have only been in use about two years, it is impossible to judge of their durability.

In Washington the terra-cotta conduit is used. This is a trough, $3\frac{1}{2}$ by 8 inches, each made of glazed terra-cotta, laid, with a proper cover, about two feet below the surface; these are connected by bracket-shaped pieces, which hold the joints in position and all laid in a heavy bed of cement; each duct is calculated to hold three 2-inch cables, but the size can be varied. The electric lighting company tried conduits of wood, asphalt and iron, but they all failed; they then used the terra-cotta and have found it very satisfactory and reasonable in price, but the cable to be used must be first class.

In New York City the electric companies could have made a success of the underground conduit work were it not for the exorbitant prices charged as rental for use of conduits, which has been $1,000 per mile per annum for a 3-inch distributing duct; $900 for 3-inch trunk, $800 for $2\frac{1}{4}$-inch trunk; to this must be added the heavy cost of cables, joints, labor, etc., with an expenditure of about $24 per mile to maintain them. The companies are then asked by the city officials to furnish all-night lights for about $75 per year; this would leave a very peculiar balance sheet at the close of the year, and, if repeated for a few years, would require the services of an assignee to adjust.

In England many plans have been adopted with varying success. Through the courtesy of the London Chamber of Commerce and prominent English electricians, we have obtained some information regarding the practical working of various systems. Ferranti uses for his high tension 10,000 volt current, his concentric cable, composed of a thick copper tube, upon which is wound a number of layers of paper saturated with an insulating wax; over this is slipped a thin outer tube of copper, for the return current and drawn down close; then he covers the outer tube with insulation and puts a lead tube covering over that and places same in the ground; wherever there is traffic, he adds an iron pipe. Notwithstanding all these precautions, he has had innumerable troubles from grounds, induction, etc.

In Liverpool the mains are laid in cast iron troughs, then filled in around them with bitumen and covered over with Portland cement; these have answered perfectly for the low tension, but they have not used high tension currents long enough to test their efficiency of durability.

In Bath, England, they use a conduit consisting of an iron trough, with iron cover, in which cables with half-inch insulation are laid on wooden bridges about two feet apart, and after cables are placed in position, the whole is filled solid with bitumen and then the iron cover fastened down. On cables laid in this way, they have carried for two years an arc current of 2,500 volts and an alternating of 2,000 volts successfully, only one ground having occurred.

After a careful and extensive examination of nearly all underground work in this country, the fact has been developed that, with very few exceptions, the system and plans heretofore adopted have proved a failure; in some cases caused by improper materials, insufficient insulation, and in many cases carelessness in laying the conduit or drawing in the cable, and in a large majority of cases, from using cable with too thin an insulation. High tension currents can be carried in conduits successfully, if the conduits are properly built and cables thoroughly insulated and carefully drawn in; but it is absolutely necessary that all work and materials should be first class,—no half-way business or effort to scrimp and save expense by thinly insulated cables or poor construction.

Investigation plainly shows that a large number of the troubles on underground cables have been caused by workmen in the manholes, as the employees of all companies have access to same; employees of one company have been extremely careless while working over the cables of a competing company and trouble has followed. This shows conclusively that each company should own and control exclusively the conduit in which their wires are placed. The plan of renting conduits is not productive of good results, unless the Legislatures of the various States pass a law, regulating the charges made for rental, and this should be the aim of the National Electric Light Association to see that laws, properly controlling the price charged for rental and use of conduits, are passed in all the States where same are used.

A serious trouble in underground work has been caused by drawing in the cables. This is a very important part of the business and should only be intrusted to reliable and experienced men, as the least injury to the insulation, while it is being placed in the duct, will surely develop and cause trouble, and many of the burn-outs have been caused in this way. No matter how good an insulation you may have, if it is cut or injured while passing it into the duct, you can depend upon it that this special place will give you notice before long, and in a way that will severely test your ability to obey one of the Ten Commandments.

Some substance must be used for the conduit that will withstand the action of the gases, soil, etc., and also resist the affectionate embrace of the Irishman's pick, used in excavating and repairing streets. Iron is not desirable, as under certain conditions and places it will be destroyed in a few months, leaving your cable exposed; cement alone cannot be relied upon; wooden conduit soon decays, besides absorbing large quantities of moisture. It would seem that glazed terra-cotta, or like substance, set in concrete was the most reliable, and with a cable first insulated with not less than quarter inch of pure rubber, this covered with a heavy braid well insulated, over this a covering of lead, and then a heavy and substantial braid, saturated with a good compound, will give satisfactory results, and can be used with high tension currents successfully and without being troubled with burn-outs or grounds. But this entails a large outlay for conduits and cables.

There is one feature of the business upon which all examinations and reports agree, that is, that the underground plan has been in use for so short a time that it is impossible to gave a fair comparison of the cost of maintaining aerial and underground circuits, but it is conceded that the expense of maintaining underground cables is far greater than aerial; also, that the durability of conduits and cables, in many cases, is mere conjecture, as they have not been used long enough to test their ability to stand the action of acids, gases and various other requirements, which can only be determined after a sufficient time has elapsed.

In cities of less than 200,000 inhabitants, compelling companies to place their wires underground will practically prohibit the use of electricity for lights, and leave the inhabitants of those cities to meander through the streets, guided by the sickly rays of the kerosene lamp, or the feeble flutter of the gas burner, as no electric lighting company can afford the expense that this would incur, unless they could obtain double the prices now paid for lights.

The expense of conduits and underground cables is so heavy that they can only be adopted in a few of the larger cities, thickly settled, and then the electric lighting companies adopting them must be paid a higher price for service, or eventually their company will be bankrupted by the expense and loss entailed. Therefore the taxpayers in any city, who demand that wires shall be placed underground, want to realize the fact that this move means increased cost for lights and larger taxes to pay for same. From data obtained, it is evident that nearly all the cities could be served with aerial lines for the high tension current in a more acceptable manner and at less expense than with underground conduits, and they could be so arranged as to be perfectly secure and not in any way endanger the public or mar the general appearance of the streets. But as this committee were appointed to investigate underground and not aerial circuits, they have not considered it within their province to describe or recommend a plan for aerial lines.

Mr. Nicholls inquired whether the creosoted wood conduit referred to costs $4,500 per mile, per duct, or for the whole conduit.

Mr. Francisco stated that it was the cost for two ducts in the conduit.

Mr. Hering referred to the system of bare conductors used for distribution in Paris and London which were placed on insulators in conduits under the sidewalks.

Mr. Francisco drew Mr. Hering's attention to the fact that all these conductors were for low-tension distribution only, while his report referred to high-tension distribution.

Mr. Wilmerding thought that high-tension underground conductors are perfectly practicable if properly carried out and enough money be invested in them. They had succeeded in Chicago in transmitting currents underground without any trouble. He did not believe in systems of conduit which are recommended as being insulated. The iron pipe for conduits was just as good as a non-conductor, except for the fact that it will rust out and become useless in four or five years. The main point to be considered in the conduit, was to get a certain strength and elasticity, so as to prevent the conduit from cracking with the action of frost and other causes, and yet be easily repaired. He believed that wood is one of the best substances for conduits. In Chicago they had had very satisfactory results with it. We know that any wood that is kept constantly moist, is practically everlasting. It had the further advantage of being very cheap. He had 40 miles at present of a certain cable, with an insulation of $\frac{5}{32}$ of an inch in thickness, which is carrying a potential of 500 volts on a constant potential motor service, one of 1,000 volts in an alternating service, and one of 2,500 to 3,000 volts in arc lighting service, and which have been in service for over two years, and he had not had a single case of grounding, burn-out, or anything of the kind, on 40 miles of conduit.

Mr. Hering stated that at the Frankfort exhibition last summer, there was an underground cable, in which an alternating current of 20,000 volts was carried for a distance of about a mile.

Mr. Francisco thought in regard to Mr. Wilmerding's remarks about wood, that it all depended on the locality. He knew a case of a wood conduit that had lasted less than nine months, while others had lasted 20 years. It depended on the locality and the soil. He inquired if they had not had trouble in Chicago, with conduits.

Mr. Wilmerding thought that was the case with regard to the city plant. He had been told by one of the employees who had charge of the underground circuit, that they had had trouble on one of their underground circuits for about six months past, and had not been able to locate it. Of course, that was a municipal plant. (Laughter.)

Mr. Stanley—When a high potential continuous current is placed in an underground cable there is a great strain on the insulating material, and this strain is all in one direction. As the result of that continued pressure in one direction the constitution of the insulator changes, and after six months—in some cases, I believe, in London, in even less time than that—the entire structure of the insulator changes, so that while the cable had a high specific resistance to start off with, that rapidly fell off in the same cable. In the case of alternating currents in these conductors this deterioration does not take place; in this case the current reverses rapidly, and the work done by the current passing in one direction is quickly undone by the next wave passing in the opposite direction; and thus the effects are neutralized. The effects of the alternating current are more like those of water flowing through a pipe. If we had a long pipe, filled with water, and suddenly turned it on end, the water would rush to the far end, and strike a hard blow, and there would be a water hammer effect. The longer the cable is underground, and the longer the distance, the greater is this condenser effect; and it was so great in the case of the Ferranti main, that it raised the pressure at London a great many volts higher than at Deptford, where the other end of the cable was. I think it can be generally stated that those insulations made from oil-compounds are unfit for a continuous current strain, while they are exceedingly good for alternating currents. In some cases in underground work we found that the cables did not have the capacity they were figured for; the capacity being always reduced. The resistance of the cables for alternating current was considerably higher than it ought to be; in some cases ten per cent. higher, and we were worried a great deal about it. We found that the external resistance in this cable was due mainly to the work that was done in the iron pipe which enclosed the cable, the resistance function outside of the wire, and not inside, and also that the current in the wire was not evenly distributed, a result which had been predicted long ago by Sir William Thomson. These difficulties were overcome by adopting a certain small standard size of conductors and putting in more cables.

Mr. M. J. Perry thought that it would be practically impossible to run circuits under the sidewalks of American cities. The proposition to place wires underground, in the broad sense, was admitted to be practicable, by all the best electricians, provided one is prepared to put a sufficient amount of money in it. To be able to put that money in it, it is necessary to offer some inducement to the investor for the use of his funds. He assumed that probably the main lines of the Buffalo Company represented from 25 to 40 per cent. of its capitalization. To go underground they would first absolutely have to sink that and throw it away, and that was an enormous strain on any corporation. Secondly, one would have to put in three or four times as much money as now invested for distributing purposes. Up to two years ago at least, the gentlemen from Chicago were not prepared to recommend it to investors; they were not, and could not help themselves. He presumed they had gone on and worked the thing out; but you could get no more American capital on the showing made there; American dollars did not go that way; and they did not grow that way. If we could see the books of the Buffalo Electric Light Company, he would warrant that they would not show that they were making extravagant profits, or extorting from this public, anything more than fair and just for the investment and risk of the business. They might possibly be earning a dividend, a fair return on the investment, which a man who invests his money is entitled to; that was only fair and just. The proposition to place wires underground, if carried out and consummated, would necessitate their earning a dividend on at least double their present capital. If the change is made, they will then be obliged to earn two or three hundred dollars per lamp; but they cannot raise the prices! It may be that if public pressure is put on strong enough, they can be made to go underground in Buffalo; it may be that they will be sent into bankruptcy; and it may be, that those who come in on the second deal, may reap a rich reward. He did not believe, however, that that was the province of any city government, and he did not believe that it was the intention of any intelligent public to do this, if they have been fairly and squarely confronted with the question.

MR. WILMERDING did not think it possible for any company which is operating by the overhead system, to afford to do the lighting at the same price by the underground; it certainly could not be done under any circumstances in a city of small population, two hundred thousand or less; it was practically impossible.

AFTERNOON SESSION.

MR. STILLWELL read a paper on "The Relation of Size and Efficiency in Transformers."[1]

In the discussion which followed, Mr. **WM. STANLEY, JR.**, remarked that the most efficient transformer that could be made, he believed, would be the hottest transformer. The problem of building a transformer, was to build a coil of wire and get as much iron in it as one can; that is, to surround a given amount of iron with as many turns of wire as one can; or, to surround a given size or coil of wire with as much iron as possible. He had had occasion lately, to design transformers of very high voltage, as high as 1,500 volts, and he was now designing some to deliver forty thousand watts or fifty horse power each. He found no difficulty in keeping the temperature of these transformers within reasonable limits. If filled with a homogeneous insulator, such as oil or some solid insulating compound, one can use any potential one wants, provided the discharges do not take place that occur in stratified insulation. He thought heat had very little to do with the breaking down of a properly insulated transformer.

PROF. ELIHU THOMSON—I do not exactly agree with Mr. Stanley in the statement that a transformer is better when it is hot. I would rather modify that statement in this way, that a transformer would run best if the iron would run hot and the copper as cool as possible; that is, the hysteresis losses of the iron would be diminished by the heat, and the resistance losses in the copper would be lessened by keeping it cool. If we could insulate the core of the transformer so as to prevent the escape of heat, and let it get hot, and keep the copper cool as possible by ventilating it thoroughly, we should then have the ideal transformer. I hardly agree with the statement that Mr. Stanley made that the insulation would not be injured by being hot. It is our experience that you cannot have a machine, a dynamo or any other electric apparatus run too cool, as regards the preservation of its insulation, provided it does not run so cool as to condense moisture from the atmosphere. The absolute resistance, the dielectric resistance, is highest when the substance is cool; that is, the tendency to puncture insulation is much less if you can keep your insulation cool. If you allow the insulation to heat up, its power of resisting puncture certainly decreases, until at very high heats it becomes a conductor.

MR. STANLEY stated that he did not mean to imply that it would not injure the insulation of a transformer if one had it hot enough. What he did mean to say was, that so far as the efficiency of the apparatus went, it would rather, on the whole, be improved by heating it. He questioned if the transformer of the future will have cotton or any other inflammable material in it. He was making transformers in which, if the coil is cut in two, the copper wires will be found imbedded in a solid dielectric, and the section would resemble the section of a well-constructed cable; there was nothing to burn there. A temperature change of 30 or 40 degrees would hardly affect the dielectric strength, while it would materially affect the efficiency of the apparatus.

MR. STILLWELL thought anything that was done in the direction of reducing the temperature, either in generators or in transformers, by the manufacturing companies was a direct gain to the purchaser; because taking the apparatus as it is built, such a policy tended to prolong the life of the apparatus.

MR. PERRY moved a vote of thanks to Mr. Stillwell, and to those who took part in the discussion. He believed that if by having two Conventions a year they could get two papers a year like this one they could not afford to hold only one Convention. The motion was caried.

The Committee on Safe Wiring, M. D. Law, chairman, then reported the following proposed amendments to the rules on that subject:[1]

Inside Wiring.

Art. 7. Inside conductors must not be laid in plaster, cement, or similar finish, without an exterior metallic protection.

Special Wiring.

In rooms where inflammable gases exist, the incandescent lamp and socket must be enclosed in a vapor-tight globe. This is not understood to include rooms where illuminating gases are used in the ordinary manner.

Art. 2. The word "waterproof" change to "moisture-proof," so that the article will read: Provided with a durable moisture-proof covering.

Interior Conduits.

Art. 2. Interior conduits must not be of such material or construction that will be injured by plaster or cement or other surrounding material, or that the insulation of the conductor will be ultimately injured or destroyed by the elements of its position.

After a brief discussion, the amendments were adopted as read.

MR. ALLEN R. FOOTE then read a report of fires and injuries caused by electric currents during the year 1890, being data obtained from 425 cities in the United States:

Number of members on fire force, regular and volunteer	56,498
Total number of fires for which the force was called out	39,847
Total number of fires caused by electric currents	518
Total number of injuries received while on duty	1,719
Total number of injuries received while on duty at fires caused by electric currents	35
Total number of injuries caused by electric currents while on duty	31
Total number of fatal injuries received while on duty	60
Total number of fatal injuries caused by electric currents while on duty	1

In the brief remarks following the reading of the data above, it was elicited that in the case of the single fatal injury caused by electric currents while on duty, that the man fell from a pole thirty-five feet high; and as there was no autopsy, it could not be learned what was the exact cause of death.

MR. LANE, of Cleveland, O., then addressed the meeting on the subject of lubricating oils. He said that most people were under the impression that it was necessary to use lubricating oils of high viscosity and low gravity in order to get good lubrication on heavy or high-speed machinery. After extended experiments it had been found by him that a light oil, light in gravity and low in viscosity, would give the best satisfaction in the lubrication of both high speed and heavy machinery. The oil recommended by Mr. Lane is an oil of about 32 gravity and 140 viscosity. He instanced the Calumet and Hecla mines, where lard oil was used up to two years ago, but where they now use a mineral oil. Objection was sometimes raised to oils because they produced a gummy substance; but this is usually a scale-making material, which comes from the walls of the cylinder. As a rule, any oil that will produce a gummy substance is a good oil.

MR. D. ASHWORTH then read a paper on "The Allied Powers,"[2] by Mr.

On motion of **MR. SEELY** a vote of thanks to the author was passed.

Invitations from the Brush Electric Light Company, at Niagara Falls, to visit the Falls, and from the Buffalo Railway Company, to inspect its power station and plant, were read. The meeting then adjourned.

WEDNESDAY, FEB. 24.—MORNING SESSION.

The President called the meeting to order at 10.30 a. m., and the first business was the reading of the paper entitled "From the Tannery to the Dynamo,"[3] by Mr. Charles A. Schieren.

In answer to a question by Mr. Stanley, **MR. SCHIEREN** stated that to make a straight line belt they have to use heads with heads, if the belt is made of anything else than centres; in using centres this is not necessary. The centre is perfectly straight, and it is only by the greatest stupidity on the part of the workman that he can make it crooked. He can make it crooked by stretching one side more than the other. "If we had to make all our belts from centres, it could not be done. In making belts of other than centres there is a right and left, and the workman must be careful not to change the relation. Crooked belts often come from the fact that a workman will put a left on a left, and then again a right on a left. The joints should be made shoulder on shoulder and butt on butt."

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[1] See page 214.

[1] See THE ELECTRICAL ENGINEER, Sept. 16, 1891.

[2] See page 214.

[3] See page 224.

Mr. Wm. Stanley, Jr. then read a paper entitled, "Alternate Current Motors."[1]

In the discussion which followed the reading of Mr. Stanley's paper, **Mr. Stillwell** inquired whether there was any retardation of the currents behind the E. M. F. in the circuits. Mr. Stanley replied that there was none whatever.

Mr. Stillwell—I would like to refer to the development of the Tesla motor, and to the relation of the false current to the true current, in the operation of that motor. Mr. Stanley's statement, is so far as my recollection serves me, about correct, when the motor is at full load; but the Tesla motor behaves very much like a transformer. The relation of the false current at no load is not, however, proportionate to the energy. In a transformer of the closed circuit type, when no lamps are burning on the secondary circuit, and consequently there are no currents in the secondary coil, we can obtain the true energy in the primary by multiplying the current and E. M. F. by a factor, which, for the types ordinarily used in this country, is about seven-tenths. As lamps are added to the secondary circuit, the phases of E. M. F. and the current in the primary tend to coincide, and at a partial load, comparatively small, they do coincide, practically, so that the product of current and E. M. F. shows the true energy. In the Tesla motor, the same general relation exists, and if it were possible to operate the motor without an air-gap, identically the same relation would exist. As we load the motor, the phase, the applied E. M. F. coming from the generator, and the current, tend to coincide; and while on a motor of 15 h. p., which gives about the best results, at no load we must multiply the current and E. M. F. by two-tenths instead of six-tenths, at full load we would multiply it by eight-tenths or nine-tenths; that is to say, that when a Tesla motor is turning over, the false current is very large, but there is a relatively good regulation as to energy. This does not apply to the efficiency, and the false reading is by no means as much as would be understood from the bare statement. If we were to transmit power from Niagara Falls to Buffalo, and were to use existing apparatus—about as good a method as we could use—we could have two satisfactory methods, one the two-phase or multi-phase system, and the other would be the straight synchronous system, with small starting motors to start the large ones. I think if we were called upon to supply power to Buffalo from Niagara Falls it would be a toss-up between the two methods. It would depend largely upon the amount of power to be transmitted and the potential to be employed. If it were 10,000 volts, it would be sufficiently high for a distance of 30 miles, if we were to deliver not more than two or three thousand horse power. It is probable that we should prefer to use two wires and two sets of insulators on each pole rather than to run three or four wires. The advantage of the latter would be that we could start the motors with torque, so that they could be brought up to their full speed when fully loaded. The disadvantage of the synchronous is simply that starting devices must be used; but that is a small matter, and a small portion of the necessary investment. The multi-phase and the synchronous type, when run at full load, should be operated synchronously. You will remember that the commission of distinguished engineers who considered this matter at Frankfort arrived at the conclusion that the ordinary synchronous motor, started with small torque, and without load, was a practical and sufficiently effective motor for general purposes; and the views of the commission were in favor of the alternating current, even as against the direct current, for a comparatively limited area. The only objection they raised to the system was that there was a certain amount of sparking at the commutator, and as I have seen one of those machines in operation it may be interesting to know how far it has been improved since. At that time Zipernowsky was using copper brushes, and starting the motor at low speed. The product of revolutions and the number of poles of course did not equal the number of phases at low speed, and there was sparking. The Frankfort commission undertook to measure the amount of copper that was detached from the commutator by sparking 100 times. Since that time we have very generally taken to carbon brushes; and the carbon brush applied to that motor practically gets over that difficulty. I have seen this synchronous motor start on a high number of volts, without any sparking that would cut the commutator. There is a slight discharge, but not a cutting spark. I am glad to know that Mr. Stanley believes that the so-called multi-phase motors possess no advantage over the two-phase type devised by Mr. Tesla.

Mr. Stanley—Mr. Stillwell suggested that there was a possible benefit to be derived from using a multi-phase motor system. I do not believe it. Mr. Tesla in the wonderful work that he did early on that subject outlined the exact conditions of the operations of his motor. We do not want more than two currents of 90 degrees of phase to produce a perfectly rotating field.

Prof. Elisha Gray was then introduced and made a brief address, inviting the Association to take an active part in the Electrical Congress to be held in Chicago in 1893 under the auspices of the World's Congress Auxiliary of the World's Columbian Exposition.

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1. See p. 211.

The report of the World's Fair Committee, Mr. B. E. Sunny, Chairman, was then read by **Mr. Charles W. Price**, as follows:

REPORT OF THE WORLD'S FAIR COMMITTEE.[1]

Everything in connection with the World's Fair undertaking is moving in a most gratifying and satisfactory way. The buildings and grounds are getting into a finished condition with an expedition that promises an absolute completion of the work long before the date for the opening of the Fair. From Prof. Barrett I ascertain that almost double the amount of space available for electrical exhibits has been applied for by American and foreign electrical manufacturers, and that there is apt to be just a little disappointment by parties who will not be able to get the amount of space that they will require. I think, however, that the arrangement for the care of applicants is on such an elastic basis that every one will get about what he wants. Certainly this is the temper of the Fair management.

As has been announced by the papers, the specifications are out for the furnishing of 6,000 arc lights and 92,000 incandescent lights, and 3,000 h. p. in generators for the service of the Fair, and by the middle of March the contracts will be closed, so that the work of installation can go right ahead.

The organization of the World's Fair Auxiliary, under whose auspices will be held the Convention of electricians from all over the world, is going forward rapidly and satisfactorily, under the direction of Prof. Gray, Chairman. The general plan was adopted for the Auxiliary at a meeting of Prof. Gray's committee, and has been published in the electrical papers of a recent issue. The aim of the Committee is to make the undertaking of the gathering of electricians on a comprehensive basis, and with the assistance that is being offered the Committee in every direction, I have no doubt but that the plan adopted for the Convention will be the one best calculated for the advancement of the interests of electricity. The situation could not be any more satisfactory for the prospects of the undertaking than it is.

On motion of **Mr. J. A. Seely**, the report was received and ordered placed on file; it being understood that the Committee was to continue.

Mr. George M. Phelps then presented the following resolutions in behalf of the Committee previously appointed.

Resolved: The members of the National Electric Light Association, assembled at its fifteenth Convention, desire to record their sense of the loss sustained by the Association in the death of Mr George Worthington.

He was the moving and leading spirit in calling together the company of gentlemen who organized this body seven years ago; and so long as health and strength remained to him he was foremost and unwearied in its service. From the first he appreciated the importance of the organization and its possibilities of usefulness. Busy as he was in his chosen field of journalism he found time and opportunity to lend a hand on every occasion of service.

Highly as we regard the memory of his ability and usefulness as a working member of the electrical community, we even more highly cherish the remembrance of his warmth of heart and his unselfish devotion to his friends. No one came within reach of his hand grasp without becoming his friend. If he had an enemy no one ever found it out.

Resolved: That the Secretary be requested to send a copy of this minute to the family of Mr. Worthington.

On motion of **Mr. J. A. Seely** the resolutions were unanimously adopted and ordered to be engrossed and a copy presented to the family of Mr. Worthington.

The meeting then adjourned until 8 o'clock p. m.

FEB. 24. 1892.—EVENING SESSION.

The meeting was opened by the reading of a paper entitled, "The Construction, Safety and Operation of Switchboards,"[2] by Mr. M. C. Sullivan, of New York. The paper was read by Mr. M. J. Sullivan, of Chicago.

In the discussion which followed the paper, **The President** remarked that the question of switchboards was one that came home very close to every man in a central station; and there was probably no point that central station practice was so weak in as in good switchboards.

Mr. Scott stated that they had a wooden switchboard, and according to the paper just read it was contrary to good practice. But he believed it to be fireproof, because it was wired in such a manner as to make it so. He had found that the great danger from fire with switchboards was either from a dirty connection, a loose screw or from lightning. In order to obviate the trouble from lightning he had provided each feeder with a double lightning arrester. He employs two lightning arresters on each leg of each feeder running to separate ground so as to be certain that if one lightning arrester did not act the other would. Then in order that it shall not reach the main plug cut-out to the dynamo, he put a double fuse block cut-out on each feeder, and fused that only to the limit of that feeder, fusing the dynamo cut-out to the limit of the dynamo; so that if any lightning gets past the lightning arrester and comes in it takes the feeder cut-out instead of the main cut out, from which it might arc and destroy the armature. If managers would fuse their feeders less than they fuse their dynamos, provide as good lightning arresters as they possibly can, and have men thoroughly examine the screws

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1. Abstract.
2. See page 227.

and the connections at stated times, a wooden switchboard he believed was just as good as a slate or a marble one. Mr. Scott did not believe in slatted wooden switchboards. A plain wall of well-shellacked hard wood he thought better than slats, because edges and corners are susceptible of attack where a full board is not so liable to it.

He used one of the wooden Westinghouse lightning arresters and one of the marble lightning arresters on each feeder. He had had some terrific thunder storms, that have come in and stopped the engine, but the arresters have carried them off.

Mr. E. A. Leslie—We have suffered very severely from lightning in our station in New York. On one occasion there was a bolt of lightning came into the cupola and agitated all the lightning arresters, but at the same time burnt out our station. That set us to thinking about a safer board. We then laid the matter before a manufacturing company, and they built for us a rubber board; that is to say, a slate board with rubber handles; and there was rubber all around it. And that burned out one time when there was no lightning; burned out from arcing in throwing over a heavy load from one machine to another. Then we set about building a switchboard on our own account, and we finally devised one which we think answers the purpose and affords us absolute safety. It is made up of slabs of marbleized slate, and the machine connections are run horizontally on the board and connected up by wires running from the machines overhead, and the connection is made behind the board. The line wires do not come into the switch proper at all. There is an addition to the switchboard, on top; that is a peculiar switch, a final switch. This switch is arranged so that it makes a connection on each side of the board. If you throw it up, the positive terminal, let us say, will make connection on the face of the board and the negative will make connection on the back. Both the line wires are connected with this switch, but they are securely insulated from each other, so that there is no possibility of short-circuit there. The result is that we have a throw of about 18 inches, and no arc on any load that we have thrown there yet will follow it, although our lines are very long, and the arcing is very severe. We use the plug system, and the board is arranged in two sections, so that if we are carrying our load on, say, nine or ten machines—we have 20 altogether in the board—we set up the other section with the other machines, so that in case anything happens, just the moment that you throw over those switches you will start the whole load on the other machines. The board is thus always prepared for an emergency beforehand, and lies there in readiness for just the unexpected to occur. The whole success of the board lies in that throw-over switch that I have mentioned, that final switch.

We had bad luck with lightning arresters, so we discarded them, and although we have passed through two summers of very heavy lightning storms we have not suffered any more damage in the matter of armatures than we did previously, when we had lightning arresters.

Mr. Fairbank then described briefly the Thomson-Houston switchboard. In this the lines come into the back part of the board and the machines are connected in the front. Connections are made with a plug which reaches from one board to the other. There were in his board 20 circuits, so arranged that they can couple any line or any machine with any circuit. It avoided all cables, and was perfectly safe. His switchboard is situated in the centre of the station instead of at the side. He could thus get all around it and test all the wires from the back of the board, or from the front. The wires come from each machine under the floor, and come up on the under side. The line wires go out overhead, and before they go to the wire tower they go through the lightning arresters, which are situated right above the board, in plain sight of the dynamo tenders, and where they can be easily reached. He had not seen anything elsewhere that was so entirely safe.

Prof. Elisha Gray then resumed his remarks on the World's Columbian Fair and outlined the work of the Electrical Congress, already familiar to our readers, and urged the participation of the Association.

He also read the following special announcement of the World's Congress Auxiliary :

> While electrical engineering has been included in the scheme for the Electrical Congress of 1892, it was also originally assigned to the department of engineering, for consideration in the congress of engineers. It was thought, however, by representatives of the Electrical Congress that this double assignment would tend to detract from the completeness and success of that Congress. A conference on this point was held between Prof. Elisha Gray, Chairman of the General Committee of the Electrical Congress ; Mr. O. Chanute, President of the General Committee of Engineers, and President Charles C. Bonney, of the World's Congress Auxiliary, and it was mutually agreed that the double assignment above mentioned should be cancelled and the entire subject of electricity remitted to the Electrical Congress.
>
> The importance and the magnitude of the other great interest to be considered in the Engineering Congress made their representatives feel that they could well afford to be generous to their brethren of the Electrical Congress in the matter of electrical engineering. Their courtesy in this regard will certainly be highly esteemed.

Judge Armstrong moved that a committee of three be appointed to whom the matter be referred. The motion to appoint the committee was seconded and carried, and the **President** named Judge Armstrong, Mr. F. W. Cushing, and Capt. W. L. Candee, as the committee.

Mr. Erastus Wiman then read a paper on "Electric Lighting from a Financial Standpoint."[1]

On motion of **Judge Armstrong** a vote of thanks was tendered to Mr. Wiman.

The meeting then adjourned.

THURSDAY, FEB. 25.—MORNING SESSION.

The Second Vice-President, Mr. M. J. **Francisco**, called the meeting to order.

The first business was the reading of the paper on "Franchises for Quasi-Public Corporations,"[2] by Mr. **Allen R. Foote**.

In the discussion which followed, **Judge Armstrong** believed there was no reason why one electric light company should not furnish all the electric light needed in a given city; but they are so constituted that, just so sure as that was the case, notwithstanding the fact that the company might be under government supervision, and its affairs open to inspection at all times, there would always be the question raised whether it could not be better done under this, that or the other circumstances. They were anxious to furnish at the cheapest possible price this form of city lighting which had become a necessity and so great a factor in our modern civilization; they were willing and anxious to make the cost of production less and receive only a fair profit, and give the service to the people as cheaply as they could. When they could get the people to properly understand this question from a commercial standpoint, there would be no difficulty in obtaining renewals of franchises, so that they would be practically perpetual, and the advantages set forth by Mr. Foote's plan would be gained in that way; but it could not be done by government work, by law, but by the education of the people.

Mr. C. R. Scott agreed with Judge Armstrong that people had to be educated to a true realization of the position of electric lighting companies. Once their position is properly understood, they would have no difficulty in holding their position; they would be like the Bell Telephone Company when its patent expires, it will keep its customers. If electric light companies give to their customers the best article obtainable at a reasonable price, they will be able to go right on ; there will be no danger of anybody else coming in, for there was not enough margin of profit in it.

The paper by Richard Hammond on "How to Fire a Steam Boiler"[3] was then read.

In the discussion which followed, **Mr. D. Ashworth** touched upon the fact that people had for a long time drifted into the idea that any one is capable of being a fireman; but he considered it a matter of great importance to get the best firemen and to select them with as much care as one would an engineer.

Mr. J. B. Edson agreed with Mr. Ashworth in the necessity of having intelligent firemen, and also thought that in their attempts to improve the steam engine engineers had neglected the boiler. He thought that a slight advance in pay over commercial rates, which are considered sufficient for that kind of low brute force, would often be productive of good results. On the steamship City of New York they have some intermediate dampers near the stoke-hole door, and this shuts off each furnace before the door is opened; thus preventing any ingress of cold air. He thought there should be some way found to avoid opening the doors of any furnace; it was wrong to do it, and have a continued contact of the hot with the cold air, which certainly affects combustion considerably. The rapidity with which a door is opened and closed was very important.

Mr. J. A. Seely believed there was a large field for an intelligent lot of men to follow the occupation of firemen. He paid his firemen a very good salary; and he had been so successful in the economies of his work that he proposed to raise their salary.

In answer to a question by **Mr. Coggshall**, **Mr. Hammond** stated that a depth of six inches of fuel gave the best results with either hard or soft coal.

Mr E. F. Peck stated that formerly they paid $1.75 a day to their firemen, and expected them to work twelve hours a day, every day in the year, without vacation. They now pay them $2.25 a day, and give them a week's vacation in the summer. In looking over their records he finds that where they were using $2\frac{75}{100}$ lbs. of coal per hour per lamp, they were now using $2\frac{51}{100}$ lbs. He believed that the additional wages had brought about this result.

Mr. C. J. Field remarked that in a station built by him the draft of each furnace could be separately controlled.

Judge Armstrong suggested that it might be a good plan for the Association to organize a bureau of firing.

Judge Armstrong then offered the following resolution :

> *Resolved*: That the National Electrical Light Association cordially endorses the plan of holding World's Congresses at the Columbian Exposition, and pledges its hearty co-operation to make the Electrical Congress under such auspices a success.

The resolution was carried.

Mr. E. F. Peck then read a paper entitled, "Overhead Construction."[4]

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[1] See p. 223.

[2] See p. 227.

[3] See p. 226.

[4] See p. 219.

In the discussion which followed Prof. Thomson thought that if we had our wires well planned, if they were kept from an appearance of straggling and uncertainty of direction, the public would like and appreciate a good overhead construction as much as they might an underground. It is true that it would be desirable to get the poles out of the way; but an underground system means certain difficulties and large expenses which must be paid for by the user. The chief difficulty was that the lineman is instructed to go and string up as soon as he can to light somebody's premises; he is in charge of the whole thing, and he is not always instructed in his business, and perhaps has had his training in the hanging of telephone wires. Prof. Thomson did not agree with Mr. Peck that a joint covered with tin foil was as good as a soldered joint. The tin foil might possibly keep the elements of corrosion away from the bright wire, but it did not take the place of a soldered joint.

Mr. J. A. Seely thought there was only one way of making a joint, and that was by twisting it with some kind of a sleeve. He had tried tin-foil, and found in using it that the linemen are not careful with it; after it is put around the wire, in taping it, it is often abraded, which opens the seams of the foil. He usually soldered the joints and covered them with a rubber liquid.

Mr. Peck stated that he did not mean to have it understood that he recommended a foil-wrapped joint. He simply spoke of it as one method of making a joint, when it was not easy to solder, and especially where the work had to be done in a great hurry. The tin-foil protects the joint from the effect of the rubber and is better than a plain joint.

Mr. Seely stated that he believed it was entirely a mistake to erect large poles. He thought it had been thoroughly demonstrated in the past year by the Long Distance Teléphone Company that they are failures. An eighty-foot pole is liable to break in heavy storms in winter, and surely they were carrying more weight with a copper wire on a pole than the small No. 12 wire used on telephone poles. The average pole should not exceed 50 feet in height. He saw very little use in protecting poles in the earth with any substance whatever; it was an expensive luxury.

Mr. Peck said he did not recommend high poles, and did not believe in them. That was a point that each central station man must settle for himself. In Brooklyn they were obliged to run their main lines over a street which had an elevated railway structure, and with a number of stations all along the line, which they had to jump over, and it was necessary to use a high pole. On all other lines they used a pole from 35 to 50 feet. He liked a pole about 40 feet high.

Mr. Wightman inquired as to the method of locating an open circuit on the line.

Mr. Peck replied that they had no system any more than the ordinary method with the magneto-bell. At night-time their inspectors use jumpers. He knew of no invention practicable for locating open circuits.

Mr. M. D. Law said his system was to use an arc light machine on independent power, which could be run at slow speed, or preferably to provide a special small dynamo for this purpose. In the location of grounds on all arc light circuits he used a bank of 50 to 52 volt incandescent lamps in series, using about five more lamps than the lamp capacity for the dynamos. These lamps are coupled in series, with the wire leading from each lamp to a switch, so that it may be moved to cut out 1, 2, 3, 10, 25 or 50 lamps as the case may be. By connecting one side of this lamp bank to the circuit, say the positive side, and the other side of the lamp bank to ground, one will either have the lamps burning at full candle power or perhaps not showing anything. Then by turning on or off the lamps until they are brought to their proper potential or candle power, the location of the break can be located within one or two lamps.

Mr. Wm. Stanley, Jr., said he had had occasion to look into the matter a little, and as a conclusion had found that it would not be remunerative to put wires underground until a system had been found which would displace 20 wires above ground for one underground; that meant that in the case of an arc light circuit, one would have to put 20 times as many arc lights on one circuit by some means unknown at present.

Mr. J. E. Lockwood deprecated the use of the dynamo to locate open currents, as suggested by Mr. Law, on account of its danger to the men. He believed the magneto-bell answers the purpose fairly well. If it is done with a dynamo the order should be imperative to the man in charge of starting the dynamos, that the man sent out to locate the break is the only man to give the word to start.

Mr. Law stated that during ten years' use of his methodnot a single accident had occurred.

Mr. E. A. Leslie then referred to the self-induction of overhead wires, particularly when not strung on the poles in such manner as to neutralize each other, and quoted a number of tests recently made on his lines in New York showing that in the case where a proper arrangement of the wires on the poles had been neglected, the apparent resistance of the circuit was 60 per cent. higher than in the case where this matter had received attention.

The paper on "Operation of High Tension Currents Underground,"[1] by Mr. E. A. Leslie, was then read; also the paper on "The Underground Construction of the Buffalo Railway Company,"[1] by Mr. J. B. Craven.

Judge Armstrong believed that the companies gained all the practical advantage possible under the present overhead systems and it was only a question for the public whether they would put an enormous sum of money into these subways—for it is the consumer that must pay for them—or whether they would put it in their pockets.

Mr. W. H. Brown gave a short account of the history of the New York subways. At present, on Third avenue, there are 20 ducts built for a distance of 12 miles, from the City Hall to the Harlem River; and there are probably not four occupied for the whole distance, and at no place more than 11. This is true to a great extent of the electric light wire subways; the fact being that only forty-five per cent. are now occupied the commission having designed to build for future needs. There was no doubt as to the great advantage of the underground system, and he firmly believed that in the future the necessities of the case would demand underground electric communication and power transmission.

Mr. F. W. Cushing thought that a simple wooden pump log had been found equal to, or better than, most of the more expensive conduits. The ideal conduit, of course, was a subway in its true sense; that is an arch or tunnel built under the street, large enough to walk through.

On motion of Mr. Seely the meeting adjourned until 3.30 p. m.

THURSDAY AFTERNOON MEETING.

Judge Armstrong offered the following resolution:

> *Resolved*, That the members of the National Electric Light Association extend their hearty thanks to the Bell Telephone Company, of Buffalo, and the American Telephone and Telegraph Company, of New York, and the Postal Telegraph and Cable Company for their very great kindness and courtsey in extending to us the free use of their wires; privileges of which we have shown our appreciation by a very general use, and which have helped greatly to the enjoyment of our very pleasant stay in the city of Buffalo. To our President, and the citizens of Buffalo, who have so hospitably treated us, we desire to extend our hearty thanks. We close this convention with the firm conviction that it has been the most successful one in our history.

The resolution was adopted amid applause.

The Association then went into executive session.

The following officers were elected for the ensuing year: *President*, James I. Ayer, St. Louis, Mo.; *First Vice-President*, E. A. Armstrong, Camden, N. J.; *Second Vice-President*, C. H. Wilmerding, Chicago, Ill.; *Secretary*, George F. Porter, New York; *Executive Committee* (new members), H. H. Fairbanks, Robert MacKie, C. Lee Abell; (old members), John A. Seely, E. F. Peck, Chas. R. Faben, Jr., Frederic Nicholls, M. D. Law, A. M. Young.

The next meeting of the Association will be held in St. Louis, Mo., February, 1893.

LIST OF ATTENDANTS AT THE BUFFALO CONVENTION.

New York City.—P. C. Ackerman, E. P. Atkinson, P. H. Alexander, W. M. Andres, Louis R. Alberger, Frank Ball, Jos. Barre, E. E. Bartlett, G. W. Blake, S. S. Bogart, W. H. Brown, A. S. Brown, A. G. Brown, J. Stanford Brown, E. Caldwell, Capt. W. L. Candee, F. R. Chinnock, L. F. Collins, S. L. Coles, F. R. Colvin, R. B Corey, W. F. Cullen, F. S. De Ronde, A. E. Davis, F. Darlington, Jarvis B. Edson, W. H. Eckert, H. A. Foster, C. G. Ferguson, C. J. Field, E. A. Fitzgerald, J. W. Godfrey, L. H. Hart, A. E. Hall, O. H. Hewlett, W. A. Hubbard, S. W. Hume, G. W. Hunt, W. T. Hunt, H. G. Issertel, W. J. Johnston, E. F. Kendall, J. C. Knight, A. A. Knudson, A. B. Laurence, H. Ward Leonard, E. A. Leslie, C. P. MacKie, George T. Manson, T. C. Martin, D. B. McCay, W. R. McLaughlin, G. S. Melville, Augustus Noll, W. F. Osborn, G. M. Phelps, H. W. Pool, George F. Porter, J. C. Pierrez, R. W. Pope, Isaac M. Post, H. N. Powers, H. L. Richards, S. Rosentamm, C. A. Schieren, C. A. Schieren, Jr., John A. Seely, E. W. Seymour, R. H. Sherwood, H. L. Shippy, Chas. D. Shain, Robert J. Sheehy, H. J. Smith, T. J. Smith, F. H. Sparling, M. C. Sullivan, H. M. Swetland, T. R. Taltavall, J. B. Taltavall, S. F. Taylor, W. H. Temple, C. S. Van Nuis, P. H. Van der Weyde, N. D. Webster, Benjamin R. Western, Jos. Wetzler, S. S. Wheeler, H. C. Whitney, G. L. Wiley, Erastus Wiman, E. E. Wood, W. H. Woods, G. F. Porter.

Akron, Ohio.—F. H. Bostwick, C. J. Butler, W. D. Chapman.

Baltimore, Md.—E. Carl Breithaupt, E. E. Ries, W. S. Horry, Henry Wiegand.

Boston.—C. E. Bibber, Capt. Wm. Brophy, H. S. Chase, C. C. Chesley, J. W. Cowles, Thos. Cooper, W. A. Daverin, L. S. Dumoulin, Paul G. Fielder, C. S. Haley, F. T. G. Hill, Welles E. Holmes, P. H. Hover, C. W. Houghton, J. H. Mason, Louis McCarthy, Cecil W. Mackenzie, Frank Ridlon, E. L. Ross, E. P. Sharp, Geo. R. Stetson, J. B. Smith, S. S. Sherman, N. V. Titus, D. T. Urquhart, W. F. Walker, W. L, Walker, C. A. White.

Buffalo.—C. Lee Abell, Frank W. Abbott, G. A. Burnett, A. A. Berrick, P. P. Beals, J. Bower, W. A. Chaffee, C. H. Darcy, W. A. Fenn, T. C. Frenyear, Dr. W. H. Heath, F. C. Hoddick, J. A. Hutchinson, W. S. Howard, C. R. Huntley, W. C. Jaynes, F. P. Jones, Frank Kitton, F. P. Liittle, A. W. Lockwood, H. McMann, H. B. Oakman, J. L. Osgood, A. B. Penfield, T. F. Reynolds, A. P. Roberts, Chas. Slosson, J. B. Slocum, P. K. Stern, A. C. Terry, J. W. Tillinghast, David Tucker, Geo. J. Urban, Jr., A. B. Weaver, W. T. Wilson.

Bradford, Pa.—J. H. Rose.

Bridgeport Conn.—W. C. Bryant, J. M. Orford.

Bristol, Pa.—Chas. E. Scott.

Brooklyn, N. Y.—T. E. Crossman, C. H. Faye, Jas. Ferguson, C. J. Foyle, E. F. Peck.

Camden, N. J.—Hon. E. A. Armstrong, John H. Bentley.

Canton, Ohio.—W. A. Lynch, H. M. Lyman.

Canandaigua, N. Y.—C. J. Purdy.

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[1] See p. 215.

[1] See p. 218.

Cincinnati, Ohio.—Chas. E. Jones, Luke Lilley, Robt. MacKie.

Chicago.—Wm. S. Armour, John I. Beggs, A. H. Bauer, E. L. Bunnell. W. F. Collins, C. D. Crandall, George Cutter, Elisha Gray. L. A. Gray, Edw. Ellicott, T. J. Lovett. W. W. Low, H. P. Lucas, G. G. McDuff, J. B. O'Hara, W. B. Pearson, Frank B. Platt, E. T. Powers, J. H. Shay, C. T. Waugh, C. H. Wilmerding.

Cleveland, Ohio.—J. B. Crouse, S. S. Leonard, Benj. F. Miles, I. R. Prentiss, J. D. Prentis, Fred. Scheffler.

Cuyahoga Falls, Ohio.—E. L. Babcock.

Des Moines, Iowa.—J. A. Colby.

Danbury, Conn.—E. T. Wightman.

Dayton, Ohio.—W. H. Ashton.

Detroit, Mich.—O. D. Chase, Geo. E. Fisher, F. E. Fisher, Chas. D. Jenney, J. E. Lockwood, W. H. Spicer, B. R. Van Court, H. L. Wilton.

Erie, Pa.—E. D. Curtis, A. L. Daniels, W. N. Lovell, Jas. McBrier, N. S. Possons, C. J. Sturgeon.

Fitchburg, Mass.—H. F. Coggshall.

Goldenburg, Neb.—B. Olip.

Hartford, Conn.—Chas. J. Hills, E. B. Hatch, C. E. Newton, A. H. Pease, C. L. Tolles.

Herkimer, N. Y.—John Kelley.

Houghton, Mich.—Jas. R. Dee.

Huron, Mich.—V. J. Stephenson.

Indiana, Pa.—S. M. Wheeler.

Indian Orchard, Mass.—E. L. Ross.

Jersey City, N. J.—Chas. A. Learned.

Lancaster, N. Y.—W. H. Boulton, C. V. Doty, R. J. Getz, W. C. Hodge, W. F. Holloway, F. P. Vandenbergh.

Little Falls, N. Y.—G. M. Lee.

Lockport. N. Y.—Chas. R. Bishop, I. H. Babcock, H. J. Fenton, H. J. Fulton.

London, Ont.—Chas. Goble, Chas. B. Hunt.

Lynn, Mass.—Elihu Thomson, Caryl D. Haskins.

Medina, N. Y.—W. R. Cunz.

Memphis, Tenn.—Wm. O'Hearn.

Minneapolis, Minn.—A. M. Robertson.

Montreal.—A. J. Corriveau, A. O. Hunt, David A. Starr.

Morristown, N. J.—F. J. Anderson.

Newark, N. J.—C. O. Baker, Jr., R. O. Heinrich, C. H. McIntire.

New Bedford, Mass.—Chas R. Price.

New Britain, Conn.—L. C. Whitney.

New Brunswick, N. J.—A. J. Jones.

New Haven.—C. D. Warner.

Newton, Mass.—W. C. Holmes.

Niagara Falls.—C. M. Morse, F. E. Pritchard, Benj. Rhodes.

North East, Pa.—J. R. Phillips.

Ogdensburgh, N. Y.—J. H. Findlay.

Owen Sound, Ore.—Jno. Parker.

Ottawa, Can.—W. F. Soper.

Penn Yan, N. Y.—W. Stanley Bruen.

Philadelphia, Pa.—A. Balsley, A. E. Braddell, Dr. W. H. Busk, C. H. Clay, H. A. Cleverly, H. B Cutter, A J. De amp, W. N. Famous, J. A. Hanna, Carl Hering, F. A. La Roche, C. M. McIntire, J. K. Martin, A. H. Manwaren, H. T. Paiste, Geo. E. Peifer, G. W. Vallee, Wm. H. Weston, E. G. Willyoung, E. W. Wilkins.

Pittsburgh. Pa.—Dan. Ashworth, N. H. Byam, Maurice Coster, G. T. Evans, Morris W. Mead, H. Robbins, L. B. Stillwell, Calvert Townley, G. A. Blaxter,

Pittsfield, Mass.—Chas. Atwater, C. C, Chesney, R. Fessenden, Henry Hines, John W. Noble, Wm. Stanley, Jr., W. A. Whittlesey, W. A. Whitney.

Poughkeepsie, N. Y.—J. N. Candee, Jas. B. Platt.

Port Huron, Mich.—J. W. Smith, D. J. Stephenson.

Providence, R. I.—Marsden J. Perry.

Pueblo, Cal.—E. M. Reed.

Ravenna, Ohio.—Chas. L. Rodman.

Reading, Pa.—J. L. Boyer.

Rockford, Ill.—W. B. Roberts.

Rochester, N. Y.—J. A. Almstead, J. G. Kaelber, Edgar A. Gay, C. B. Griffith, J. E. Putnam, G. A. Redman.

Rutland, Vt.—M. J. Francisco.

Sagamon, Mich.—G. A. Gilbert.

Schenectady, N. Y.—M. D. Law, F. A. Stevenson.

Seneca Falls, N. Y.—R. H. Aldrich, S. S. Phillips.

Sewickley, Pa.—E. P. Young.

Springfield, Ill.—A. L. Ide.

Salem, Ohio.—Geo. A. Barnard, D. L. Davis.

St. Louis, Mo.—Jas. I. Ayer, J. H. Rhotehamel, E. Ruebel, A. Wolfram.

Steubenville, Ohio.—J. Gwynn.

Syracuse, N. Y.—Thos. H. Fearey, E. P. Doen, F. M. Hawkins, C. F. Hayes, H. J. Gorke, J. D. McIntyre, James Pass, S. H. Riker, A. P. Seymour, F. J. Wright, F. H. Leonard.

Summit, N. J.—W. E. Doying.

Telluride, Col.—P. N. Nunn.

Tolland, Conn.—F. H. Underwood.

Toronto, Can.—Frederic Nicholls, W. J. Morrison, H. D. Thornberry, H. S. Thornberry.

Trenton, N. J.—J. T. Ridgeway, Richard K. Whitehead, Cresent Ins. Wire and Cable Co.

Utica, N. Y.—W. F. Bossart, M. G. Brayton.

Waltham, Mass.—J. T. F. Hill.

Waterbury, Conn.—D. L. Hungerford.

Warren, Ohio.—E. Metzger, W. D. Packard.

Warsaw, N. Y.—C. E. Fargo.

Washington C. H., Ohio.—Jerome Penn.

Washington, D. C.—Allen R. Foote, Fred. W. Royce, J. N. James.

Worcester, Mass.—H. H. Fairbanks.

Windsor, Conn.—M. E. Baird, A. D. Newton.

Wilmington, Del.—Frank D. Sweeten, C. R. Van Trump.

Ladies.—Miss E. W. Armstrong, Camden, N. J.; Mrs. Jos. Barre, New York; Mrs. C. O. Baker, Jr., Newark, N. Y.; Mrs. James Ferguson, Brooklyn; Mrs. M. J. Francisco, Rutland, Vt.,; Mrs. W. J. Johnston, New York,; Mrs. M. D Law, Schenectady, N Y.; Mrs. F. H. Leonard, Syracuse; Mrs. C. M. Morse, Buffalo; Mrs W. D. Packard, Warren, O.; Mrs. G. A. Redman, Rochester; Miss Redman, Rochester; Miss A. E. Redman, Rochester; Mrs. Frank Ridlon, Boston; Mrs. E. L. Ross, Indian Orchard, Mass.; Mrs. S. S. Sherman, Boston; Miss M. L. Shivers; Mrs. T. J. Smith, New York; Mrs. T. J. Smith, New York; Mrs. N. V. Titus, Boston; Mrs. Schuyler S. Wheeler, New York; Mrs. E. A. Willyoung, Philadelphia.

CONVENTION EPISODES.

On Tuesday evening President Huntley and Mr. George Urban, Jr., entertained a select party of guests at the Buffalo Club, including Prof. Elihu Thomson and Messrs. Wilmerding, Ayer, Wilder, Candee, Baker, as well as a number of leading Buffalo citizens. A most delightful time was spent, and supper was followed by several interesting and witty speeches. It was 4 a. m. before the party broke up.

The Association has reason to congratulate itself upon the active participation in its work of such distinguished electricians and inventors as Prof. Elihu Thomson, Dr. Elisha Gray and William Stanley, Jr. The cheers proposed to Prof. Thomson by Mr. Stanley at the banquet, were given by the gathering with tremendous enthusiasm; while the presence of Dr. Gray and his happy, off-hand speech closing the dinner will long be remembered as a leading event of the Buffalo Convention.

The arrangements made by Mr. C. O. Baker, Jr., for the Electric Special from New York on Monday proved most satisfactory. The train started at 11 a. m. and consisted of six cars, including dining and buffet smoker. The pleasure of the trip was added to by the performances of a mandolin band, and the taking of group photographs at Albany and Utica. At Albany, the Boston contingent, under the care of Mr. A. C. Shaw was picked up. At Rochester the train was met by an advance guard from Buffalo, headed by President Huntley.

Never did a President of the Association devote himself more assiduously to the manifold duties of host, than Mr. Huntley, and he was most ably backed up by such men as Messrs. George Urban, Jr., C. Lee Abell, H. B. Oakman, F. P. Little, R. J. Getz, Daniel O'Day, F. V. Doty, W. G. Case, W. A. Fenn, to one and all of whom, as to many others, the members of the Convention are under many obligations for thoughtful attentions and lavish kindnesses. Much credit is due to the various committees and executive officers for their well-laid plans, as the result of which everything went off without a hitch.

One of the most delightful episodes of the week was the reception given on Tuesday evening by Messrs. Candee and Manson in the Okonite parlors, which were crowded not only by the delegates but by ladies. With a felicity that has been shown more than once, the hosts had provided a special form of entertainment, being nothing less than a series of monologues and recitations by the inimitable Marshall P. Wilder, who was never in better vein, and who kept his audience in convulsions of laughter. Refreshments were provided, and several musical members assisted with songs and piano solos. By unanimous and overwhelming request, the conversazione was repeated on Wednesday evening.

Considerable pleasure was afforded to a large number of delegates by the opportunity to visit and inspect the fine plant of the Buffalo Street Railway Co. On Thursday afternoon a special trip over the road was organized by Mr. C. J. Field, of the Field Engineering Co., which did all the work on track, line and power-house, and three or four hours were spent most profitably. The inspection of the power-house was quite prolonged, as there were many points of interest in the original methods adopted and in the routine work since laid out by Mr. Littell, the manager. The power-house has twice been very fully described in The Electrical Engineer, especially the fine outfit of Ball engines, Hammond engines, Edison generators, Babcock & Wilcox boilers, etc.

A word of praise is due to Mr. George F. Porter, Secretary of the Association, for his good work. It was a matter of general comment that never before had the N. E. L. A. enjoyed so smooth-running a Convention and such complete arrangements. A specially good feature was the system of distributing badges. Hitherto it has been the custom to give out badges indiscriminately. This time, however, the bellboys and bootblacks had to go without. Each company was furnished with a button badge for its representative, whether active or associate, and other ribbons were provided for visitors and extra representatives. For these ribbons, silver buttons were furnished at the moderate charge of $1, while an equal sum would also buy a badge pin for the ribbon of any of the ladies of the Convention. In this way, the distribution of the badges was kept within proper bounds, yet all could get them who were entitled to them for their membership dues, or as visitors were willing to pay modestly for the distinction and for all the privileges that wearing the button conferred.

A full programme of business had been arranged for Wednesday afternoon, but it was wisely decided to postpone the session until the evening, so that the Convention might inspect the Niagara Hydraulic tunnel. A special invitation was received from Mr. Rhodes, the president of the Niagara Falls Brush Co., and from C. B. Gaskill, president of the Niagara Power Co.; Messrs. Burbank and Porter, engineers of the Cataract Construction Co., and Rodgers and Clement, the contractors. A special train was kindly furnished by the N. Y. Central R.R. Co., and it was fully loaded by about 350 members and ladies. On arriving at Niagara Falls the ladies were received by Mrs. Rhodes, and after being driven around the Falls in carriages, were entertained at her residence. The masculine part of the Convention devoted itself meantime to a very thorough inspection of the 1¼ mile of tunnel already made, and then visited the Brush station, where Mr. Rhodes, with his wonted hospitality, had prepared lunch and a punch bowl which showed how familiarity with a great body of water breeds contempt for it. Such of the members as restricted themselves to but one glass of punch also visited the Suspension Bridge, or coasted in a most reckless manner on the ice mountain below the American Fall. The train returned a little after five, and, as if to intensify the pleasure of the occasion, ex-President Cleveland passed through just ahead of it on a special train—an opportunity that was made the occasion of no little cheering and handshaking. Altogether the afternoon was a holiday long to be remembered, and its beneficial effects were seen in the zeal with which the business programme was attacked in the evening.

The Convention was brought to a close by a banquet given by the citizens of Buffalo, to the National Electric Light Association, on Thursday evening, at the Buffalo Board of Trade. Between 350 and 400 gentlemen sat down to table about 8.30. The large hall was beautifully decorated and the effect was greatly enhanced by standards of small incandescent lamps, with colored shades and draped with smilax, placed on the several tables. The floor had to be specially wired for this work, and the work was not at all of an easy nature, but the result was eminently creditable to F. P. Little & Co. who made and carried out the design. The menu was an excellent one, with choice wines to grace it, and it was printed in a very tasteful and orignal manner on heavy cards, with elaborate ornamentation including views of Buffalo and a satirical drawing of the conditions in which electric light stockholders find themselves. Mr. Scatcherd, president of the Board of Trade, acted as toastmaster, and after a few words of welcome from Mr. Huntley, the retiring President, the following programme of speeches was gone through: "The City of Buffalo," Mayor C. F. Bishop; "The National Electric Light Association," Hon. E. A. Armstrong; "Buffalo Manufacturers" Richard K. Noye; "Municipal Lighting," C. H. Wilmerding; "Buffalo Electricity," John G. Milburn; "The New President," James I. Ayer; "The Electrical Press," T. C. Martin; "The Buffalo Press," Mr. Kingsley of the *Enquirer*; "Electricity," Prof. Elihu Thomson. "Our Partners in Niagara Falls," A. J. Corriveau; "The Dusty Miller of Buffalo," George Urban, Jr.; and "The Electrical Congress of Chicago," Dr. Elisha Gray. The banquet closed about 1.15 a. m.

CONVENTION NOTES.

The Thomson-Houston Carbon Company were represented by Mr. D. T. Urquhart, who appeared to know every one and to be known by every one.

J. H. Bently represented the Century Pottery Co., of Camden, N. J., and was kept busy telling the merits of his company's productions as used in electrical work.

The Bryant Electric Company, of Bridgeport, Conn., had Mr. W. C. Bryant on the field again, and showed their usual line of Bryant sockets, switches, cut-outs, etc.

Frank Ridlon, of Boston, was there too, and exhibited himself in all his imposing grandeur to his numerous friends and gave absolution to all who required it—and they were not few.

The Eco Magneto Clock Company, of Boston, were represented by Mr. C. A. White, of Boston, who demonstrated the value of his system of watch clocks to all interested in that branch of electricity.

The Ashton Valve Company, of Boston, were represented by Mr. C. W. Houghton, of Boston, who seemed to know all the central station men, and explained the advantages of using Ashton pop safety valves.

The Economic Electric Manufacturing Company, of Boston, were represented by Mr. Titus, who did not show any samples but depended chiefly on the well-known reputation of the Economic lamp for his text.

The Johns Pratt Company, of Hartford, were represented by E. B. Hatch, of Hartford, who advocated strongly the use of Vulcabeston spools for all dynamos and motors, and for electrical insulation generally.

The Bernstein Electric Co., of Boston, were represented by Mr. C. A. Fish, who brought with him a few samples of the well-known Bernstein incandescent lamps, sockets and other specialties.

The Standard Electric Time Co., of New Haven, Conn., were represented as usual by Mr. C. D. Warner, who showed a few samples of their clock movements, and also samples of the well-known Warner electric gauge.

The Simplex Electric Company, of Boston, were represented by Mr. J. H. Mason, of Boston, who had a few samples with him of the favorite Simplex wire, and his pockets full of "testimonials" from all over the country.

The Samson Cordage Works, of Boston, were represented by their treasurer, Mr. H. B. Pratt, of Boston, who induced many to believe during his stay in Buffalo that the Samson cord was the correct thing for suspending arc lamps, and for trolley cords.

Kerite.—The interests of "Kerite" were taken care of by Mr. F. W. Cushing, general Western agent, and Mr. Wm. H. Eckert, general agent. Mr. Eckert has been on a trip through the West, and spent one or two days at the Convention while returning.

The W. T. C. Macallen Company, of Boston, were ably represented by Mr. Louis McCarthy, who showed to all interested samples of his insulated joint for gas and electric fixtures, a joint which has met with much success since its introduction a few months ago.

Hart & Hegeman, of Hartford, Conn., were well represented by their new treasurer, Mr. A. H. Pease, who made a large number of friends, and interested all in the Hart snap switch in various sizes. The large 60-ampere one seemed to meet with general favor.

The Benedict & Burnham Manufacturing Company, of Waterbury, Conn., had as a representative, Mr. D. L. Hungerford, of New York, who had a few samples of their insulated wires on exhibition. Their new "Benedict" wire seemed to meet with general approbation.

Jewell Belting Company, of Hartford, Conn., were represented as in past years by Mr. C. E. Newton and Mr. C. L. Tolles, who seemed to find an opportunity occasionally in the midst of their other pursuits to discourse on the merits of cutting dynamo belts from the *centres* of hides and centres only.

The Perkins Electric Switch Company, of Hartford, were represented by Mr. Bunch, of Hartford, who made his maiden trip to an electric light convention, but went away with a pleasing memory of Buffalo. Incidentally, Mr. Bunch showed a few samples of the Perkins switch, rosette cut-out and other specialties.

The Boston Braid Manufacturing Company, of Boston, who manufacture a very fine quality of silk braid, exclusively used for the filaments of incandescent lamps, were represented by Mr. Paul G. Fieldler, of Boston, who had his pockets full of samples, which were eagerly sought by the lamp manufacturers present.

The American Circular Loom Company, of Boston, were represented by their general manager Mr. H. H. Brooks, of Boston, who showed a number of samples of the well and favorably known Canvas Jacket insulated wires, and also of their new interior conduit, which is also protected by the canvas jacket covering.

H. B. Cutter, of the Cutter Electrical and Manufacturing Co., was not wearing bracelets as was supposed by a great many, but was simply employing a convenient method of carrying a section of his new flexible metallic tubing for portables and brackets. Their handsome double push-switch enjoyed a great deal of attention also.

The Chapman Valve Manufacturing Company, of Boston, had on the ground, their popular representative, Mr. E. L. Ross, who is well posted on all the steam engineering problems of the day. Mr. Ross says that the Chapman valve is the ideal valve for high pressure steam, and electric light and power plants are rapidly adopting it.

The Consolidated Electric Manufacturing Company, of Boston, were represented by their well-known general manager, Mr. C. E. Bibber, who showed a few samples of their well-known specialties, such as sockets, jack-knife switches, rosettes, etc., etc. Mr. Bibber also gave away a very neat little card counter, which was highly appreciated.

The Beacon Vacuum Pump and Electrical Company, of Boston, were fortunate in securing a space in the hall of the hotel, and the indefatigable Mr. S. S. Sherman, of Boston, soon had a number of the Beacon lamps from 16 to 150 c. p., all brilliantly illuminated. The Beacon Company are young, but they made a "strike" at the Buffalo Convention.

The Gould & Watson Company, of Boston, were well represented at the Convention, and showed samples of their new waterproof sockets made to fit either Thomson-Houston, Edison or Westinghouse base. Mr. E. P. Sharp, who had charge of the exhibit, showed also a few samples of the new Whitney voltmeter and ammeter, for which they are sole selling agents.

Mr. A. L. Ide, of Ide engine fame, was at the Convention.

Mr. A. H. Bauer, of the Pullman Palace Car Co., was on the ground.

Mr. Geo. E. Fisher, of the Commercial Electric Co., of Detroit, was there.

Mr. E. Rubel, manager of the St. Louis Electrical and Supply Co., was in attendance.

Chas. E. Jones, of Jones Bros., Cincinnati, was on hand. He will also be at St. Louis.

Mr. W. A. Fenn looked after the interests of the American Electric Supply Co., of Buffalo.

John A. Roebling's Sons Co. was well represented by Mr. H. L. Shippy and Mr. F. H. Sparling.

Mr. Frank De Ronde represented the interests of the Standard Paint Co. in an unusually genial manner.

Mr. W. J. Ashton, of the Dayton Fan and Motor Co., of Dayton, O., was present through the Convention.

Mr. A. B. Laurence, of the Shultz Belting Co., was well furnished with samples of the famous Shultz belt.

The Jenney Electric Motor Co., of Indianapolis, were represented by Mr. Chas. D. Jenney at the Convention.

Mr. Chas. Rodman, of the Globe Carbon Co., of Ravenna, O., was here and there and everywhere during the Convention.

Mr. Chapman, of the Akron Electrical Mfg. Co., was present during the Convention telling about the apparatus he manufactures.

Mr. F. P. Little, of Buffalo, was around all the time. He was able to show a number of fine plants installed by his company.

Mr. H. K. Gilman, manager of the Great Western Electric Supply Co., put in an appearance and was warmly welcomed on all sides.

Mr. W. D. Graves represented the W. D. Graves Electrical Manufacturing Co., of Cleveland, which is building a low-tension arc lamp.

The Eureka Tempered Copper Co. made a fine exhibit of their tempered copper specialties and were represented by Mr. N. S. Possons.

Mr. W. B. Roberts, general manager of the Rockford Electric Mfg. Co., of Rockford, Ill., was present and looked after the interests of his company.

Mr. Chas. E. Bibber, general manager of Consolidated Electric Mfg. Co. of Boston, was at the Convention and made things hum for his company.

Mr. Geo. H. Meeker, Chicago manager of the N. Y. Insulated Wire Co. was in attendance and Grimshaw and Vulca duct were right in it all the time.

Mr. B. F. Miles, of the National Carbon Company, received his usual hearty welcome. He has a host of friends, and his carbons are always in demand.

Pass & Seymour showed a fine assortment of their vitrified china specialties and several of their representatives were on the ground doing the honors.

Mr. Fred. V. Doty, general manager of the Aluminum Carbon Co., of Buffalo, was around all the time looking after the wants of central station men for his carbons.

"Ajax" Van Nuis had the combination but kindly distributed the key to all desirous of securing "protection" from it. Test it in a genuine electric storm and be convinced.

The Detroit Motor Co. were ably represented by Mr. Van Court and Mr. Armour, who made a very elaborate exhibit of their motors and generators, rheostats and switches.

Mr. R. N. Lovell, of the Lovell Mfg. Co., of Erie, Pa., was present. He did not bring a motor, however, as customers are taking them faster then his shop can turn them out.

Mr. W. B. Cleveland, of the Forest City Electric Works, Geneva, O., attended the Convention and explained the advantages or his specialties for lighting and railway work.

Mr. A. P. Seymour, of Pass & Seymour, Syracuse, joined the electric special contingent at Syracuse, and was at all times willing to be consulted regarding the specialties of his company.

The Indiana Rubber and Insulated Wire Co., of Jonesboro, Ind., were looked out for by Mr. Butler, who had some fine sample cases of the company's Paranite wires and cables.

The Security Porcelain Insulator was one of the novelties, and Mr. A. S. Brown was very successful in getting rid of a trunkful of samples. The insulator claimed a great deal of attention.

The Keystone Electric Co., of Erie, showed their reversible motors, and the attention they attracted was very noticeable. Mr. C. J. Sturgeon was on hand to explain the mysteries of the only instantaneously reversible motor that operates with a special switch and entirely without rheostats of any kind.

The Falls Rivet and Machine Co., of Cuyahoga Falls, O., distributed a handsome circular list of some of their power transmission plants. Mr. E. L. Babcock, president of the Co., was in attendance.

Mr. Henry B. Oakman, of the Buffalo office of the Edison General, made a most striking exhibit in their handsome store, and had a large bottle of ink ready for his many friends and correspondents.

The Okonite Company occupied parlors E and C of the Iroquois and were ably represented by Captain Candee, Col. Geo. T. Manson and their local agents, Messrs. Morse & Eames, of the Buffalo Engineering Co.

Mr. W. D. Packard, of the New York and Ohio Co., was present to tell all about Packard perfected incandescent lamps. He was quite satisfied with a little record of tests he found posted up in the Niagara Falls Brush station.

Col. J. H. Shay, of the Munson Belting Co., was right on the spot, as he always is at Conventions, and held up his end in his usual accomplished fashion. He is the only man in the world who has ever "caned" a whole Convention.

The Otis Bros. Electric Elevator Co. were on hand with one of their new electric pumps, an exceedingly ingenious piece of machinery. It was operated by a one-half horse power Crocker-Wheeler motor. Mr. A. E. Hall explained its merits.

The Hill Clutch Works, of Cleveland, had their Mr. S. S. Leonard, on the ground with some very handsome photographs of their clutches and transmission machinery in the Brush station. Mr. Leonard chartered a bus and took all those interested to see the plant.

The Mitchell-Brant Copper Co., of Erie, Pa., were represented by Mr. A. L. Daniels who exhibited a number of tempered copper commutator segments. They manufacture a segment exactly to angle guage, guaranteed pure copper and of a quality and workmanship to satisfy the most critical.

The New York Insulated Wire Co. had an A1 delegation of representatives. George Meeker, who has been in charge of the Western business since the opening of their branch in Chicago, was there, and all were glad to see him. J. W. Godfrey was there, of course, and all well remembered Gus. Noll and C. A. Place, as being present.

The Eddy Electric Manufacturing Company, of Windsor, Conn., were represented by Mr. A. D. Newton and Mr. M. E. Baird, and circulated around amongst their innumerable friends in their own happy way. They say that they never require to bring samples of their motor now-a-days; it is too well known, and besides there are any quantity of them in every city you can go to.

Claflin & Kimball, of Boston, who are now the sole selling agents for the Mather Electric Company of Manchester, Conn., and the Perkins Electric Lamp Company also of Manchester, Conn., were represented by Mr. Charles J. Hill, who seemed to impress the Convention with the fact that the Perkins lamp was a good one, and that the Mather dynamo would now be more popular than ever.

The Electric Pole Switch Company, of 36 Niagara street, Buffalo, showed a very novel arc light pole switch. The wires are attached to a separate and stationary base; the trimmer draws the lamp toward him preparatory to trimming, and the instant the lamp leaves the base or switch all connections are severed, and danger thereby averted. When the lamp is pushed back into position, the connection is again made almost automatically.

Mr. George Cutter, of Chicago, was around talking the merits of a new lamp-hour recorder, of which he has sold 100 to a single station, and he has now ready for the market some 500, which will probably disappear very rapidly. This recorder is adapted for either continuous or alternating currents, and also for arc lamps, which is somewhat of a new feature, so that a man can have his arc lamps on tap and use them just as he desires.

The Electrical Appliance Company, of Chicago were represented by their president Mr. W. W. Low who had his pockets full of Paranite wire, swinging ball lightning arresters, and their other specialties. Mr. Low also made arrangements to handle several new specialties of general utility and from which he expects a large sale amongst the central stations of the West. He also exhibited New England and Acme switches and several other new and valuable devices.

Mr. J. D. McIntyre took excellent care of the interests of the Electric Engineering and Supply Co., of Syracuse, showing a number of their popular specialties. Noticeable among these was their new incandescent locking switch, also a specially designed porcelain tube for use in running wires through partitions, etc. The locking switch is designed for use in hotels, theatres and public places generally where ordinary switches are used by the crowds as an object of amusement rather than the use for which they are intended. The attendant has his key and uses it when desired.

Prof. R. O. Heinrich was untiring in his efforts to entertain his many friends and the friends of the Weston Electrical Instrument Company.

F. P. Little & Co., at their store, 141 E. Seneca St., showed some of the Crocker-Wheeler motors. The motor company was represented by Dr. S. S. Wheeler.

Partrick & Carter Co.—The interests of Partrick & Carter were well taken care of by Mr. E. Ward Wilkins. They gave out a very neat little memorandum book.

The Findley Mast Arm manufactured by the Utica Electric Mfg. and Supply Co. was shown and its good qualities explained by Mr. Findley at 270 Iroquois Hotel.

Captain William Brophy, of the Fire Underwriters' Union, was circulating around the Iroquois Hotel, renewing all his old friendships and forming many new ones.

Thomson Recording Watt Meters were exhibited at the Iroquois in Parlor 62. No little interest centered there as was evidenced by the number of delegates and visitors wearing *seals* which were attached to all who visited this exhibit.

Mr. J. K. Martin represented Jas. J. Murray & Co., of Philadelphia, and it was a pleasure to see him entertaining the numerous visitors at his parlor where he showed a very handsome line of arc and incandescent globes in rich cut and flint glass.

Mr. Elias E. Ries, president of the Ries Electric Specialty Co., of Baltimore, was there with his ingenious regulating socket. The wonderful success of this novel socket in the six months just passed is too well known to necessitate any recapitulation.

Mr. Richard R. Whithead, vice-president and treasurer of the Crescent Insulated Wire and Cable Company was there in the interests of, and took every opportunity to extol the merits of, his company's wires. This was Mr. Whithead's first Convention and he certainly made a host of friends.

The American Electric Works, of Providence, R. I., were represented as usual by Mr. P. C. Ackerman of New York, who appeared to enjoy himself in his customary happy way, and succeeded in interesting all in his samples of electric light wires and cables and all the other products of the large factory in Providence.

The Union Electric Manufacturing Company of Bridgeport, Conn., were represented by Mr. J. M. Orford, of that city. Mr. Orford always goes provided with a socket in his pocket, and was ready to prove conclusively to one and all that the Union socket was one of those things, that only the best were worth having, and that he had the best.

The Stanley Electric Co. of Pittsfield, Mass., were well represented by Mr. Stanley and Mr. H. Hine, the former taking an active part in the discussions while the latter devoted himself to the pressing business matters of the hour, a great many of the delegates desiring to get particulars as to the Stanley converters, alternating current motors, etc.

Mr. C. P. Corey, treasurer and general manager of the Electric Construction and Supply Co., was here, there and everywhere, and it is needless to say that the "Ward Lamp" interests received all the attention required. Mr. Corey made a beautiful exhibit of their photo-engraving lamp and their search-light, both operating on 110-volt circuit.

The National India Rubber Company of Bristol, R. I., who have within the past year commenced the manufacture of high-grade insulated wires and cables, were ably represented by the manager of their electrical department, Mr. F. S. Minott, of Bristol. This was Mr. Minott's first visit to an electric light Convention, but he soon made numbers of friends and interested many in the excellent quality of his samples.

The Electric Secret Service Co. were represented by Mr. C. P. MacKie, Mr. Robt. MacKie and Mr. S. S. Bogart. They showed their individual motor and arc light cut-out, the working of which seems almost miraculous as they were able to demonstrate the possibility of cutting around any number of lights and cutting in or out at will any particular light desired. This certainly novel device must be seen to be appreciated.

C. S. Knowles, of Boston, who are large dealers in the finest quality of porcelain goods for all electrical purposes, had a very pretty line of samples in the care of their Mr. Bell, of Boston. Mr. Bell showed some very interesting samples of his goods to many of those present, and seemed to make a very favorable impression. Mr. Knowles, besides dealing in porcelain goods, has a number of other articles equally interesting to the electric public.

Utica Electric Mfg. & Supply Co.—A great deal of interest was centered around Room 270, where a genial delegation represented the Utica Electric Mfg. & Supply Co. This company are just introducing some very novel specialties, so much so in fact that they must be seen to be appreciated. Mr. Brayton, Mr. Bossart and Mr. Findley did the honors. A full description of a most ingenious type of lightning arrester and quick-breaking and absolute-locking switch is impossible at this writing. They issue circulars however that explain fully the workings of their devices.

Knudson-Cuttriss Wire Co.—The new K. C. wire made by this company of the Drexel Building, New York City, was exhibited in Room 104 of the Iroquois Hotel. While the Convention remained in session, two large coils were kept submerged in water with 110-volt current passing through it, but not the slightest leakage was shown. As this wire is of the fibre class, with no rubber or gutta-percha in the material used for insulation, this test excited much attention and interest among wire men.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEBRUARY 16, 1892.

Accumulators:—

Storage Battery, C. P. Elieson, 469,129. Filed June 4, 1891.

Employs electrodes built up of a series of corrugated envelopes.

Alarms and Signals:—

Signal for Electric Railway Systems, F. A. Cheney, 468,787. Filed Sept. 10, 1891.

A system of electric block signals for electric railways.

Means for Indicating Discharge from or into Hoppers, F. H. Briggs, 468,970. Filed Apr. 29, 1891.

Conductors, Conduits and Insulators:—

Electrical Conduit, E. T. Greenfield, 469,208. Filed May 13, 1891.

Claim 7 follows:

'A conduit tube consisting of two tubes of insulating material completely surrounded by a metallic sleeve which joins them together.

Distribution:—

System of Distribution of Electrical Heating Currents, G. D. Burton, 468,938 Filed May 14, 1891.

Has for its object to distribute heating currents of different volumes for forging, etc.

Dynamos and Motors:—

Commutator-Brush for Electric Motors and Dynamos, T. A. Edison, 468,950. Filed Apr. 4, 1891.

Consists in an arrangement with bridges of high resistance between the commutator bars.

Field Magnet for Dynamos and Motors, R. Lundell, 468,953. Filed June 6, 1891.

A multipolar motor occupying small space and efficient and of low speed.

Armature for Dynamo-Electric Machines, M. Deprez, 469,080 Filed Dec. 7, 1885.

An armature coil constructed in separate sections which may be slipped on and off without disturbing each other.

Dynamo-Electric Machine or Motor, H. M. Byllesby, 469,193. Filed June 8, 1891.

A dynamo or motor having concentric field magnets and armature, both journaled in suitable bearings and free to rotate, the one within the other.

Galvanic and Thermo-Electric Batteries:—

Electrolytic Cell, E. A. Le Sueur, 468,880. Filed June 6, 1891.

Electrolyte Solution for Galvanic Batteries, S. Miller, 468,887. Filed Oct. 16, 1891.

An electrolyte consisting of nitrate of soda, bichromate of potash, chloride of sodium and sulphuric or hydrochloric acid, or both.

Lamps and Appurtenances:—

Electric-Arc Lamp, R. S. Dobbie, 469,041. Filed Oct. 23, 1890.

Has for its object to produce a smooth and even feed and also to automatically re-form the arc when broken.

Suspending Device for Electric Lamps, J. J. Renehan, 468,048. Filed Jan. 30, 1888.

A yard arm for arc lights.

Electric Search-Light, N. Weeks, Jr., 469,050. Filed June 4, 1891.

Electric-Arc Lamp, H. Sawyer, 469,093. Filed Feb. 24, 1891.

An arc lamp automatic in its action carrying a number of carbons and supplying them to the holders when required.

Miscellaneous:—

Magnetic Lock, A. E. Kintner, 468,807. Filed Sept. 3, 1891.

Electric Elevator, R. C. Smith, 468,903. Filed Aug. 28, 1891.

Electric Brake Mechanism for Elevators, C. E. Moore, 468,917. Filed Nov. 4, 1891.

Coin-Freed Machine for giving Electric Shocks, J. Mason, 468,955. Filed Mar. 14, 1891

Electric Curling-Iron, A. F. Godefroy, 469,135. Filed June 26, 1891.

Electric Letter Box, C. A. Pinkham, 469,181. Filed July 3, 1991.

Railways and Appliances:—

Trolley for Electric Cars, J. W. Beebe, 468,779. Filed Mar. 10, 1891.

Has for its object the diminution of friction, the prevention of loss of force resulting from an accumulation of ice on the wire and the maintenance of a constant contact.

Turn-Table Connection for Electric Railways, R. M. Hunter, 468,912. Filed Feb. 17, 1886.

Electrically Propelled Car, H. E. Dey, 468,948. Filed July 14, 1891.

A system of gearing consisting of two rotary pumps, the one on the armature shaft and the other on the driven axle connected by pipes.

Converter System for Electric Railways, T. A. Edison, 468,949. Filed March 8, 1887.

Has for its object to overcome the loss from leakage on the contact conductors of electric railways.

Electric Railway, F. J. Sprague and P. F. O'Shaughnessy, 468,959. Filed Jan. 19, 1889.

Has for its object an arrangement of the switch plate in a trolley system such that the contact device will be readily guided to its proper outlet.

Switches and Cut-Outs:—

Multiple Switchboard, W. Moseley, 468,818. Filed Dec. 26, 1888.

An arrangement whereby, when a line is once connected at one board, the fact of such connection is made known automatically at other boards.

Electric Cut-Out, V. A. Thomas, 469,220. Filed May 15, 1891.

Telephones and Apparatus:—

Telephone Transmitter, E. A. and T. Grissinger, 469,085. Filed Sept. 16, 1891.

Claim 1 follows:

In a telephone transmitter a diaphragm consisting of a film of suitable material enclosed by a substantially homogeneous strongly coherent body of carbon.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The Buffalo Convention was a good advertising medium, but the technical journals are better.

THE "AMERICAN" HIGH-SPEED ENGINE FOR ELECTRIC LIGHTING.

THE direct connection of the steam engine with the dynamo presents such well-recognized advantages that they require no further elaboration, but it is evident that with a reciprocating engine the speed is limited. To overcome this drawback Mr. Elmer Stillman Smith has designed a novel type of engine which is now being built in a variety of sizes by the American Engine Co., of Bound Brook, N. J.

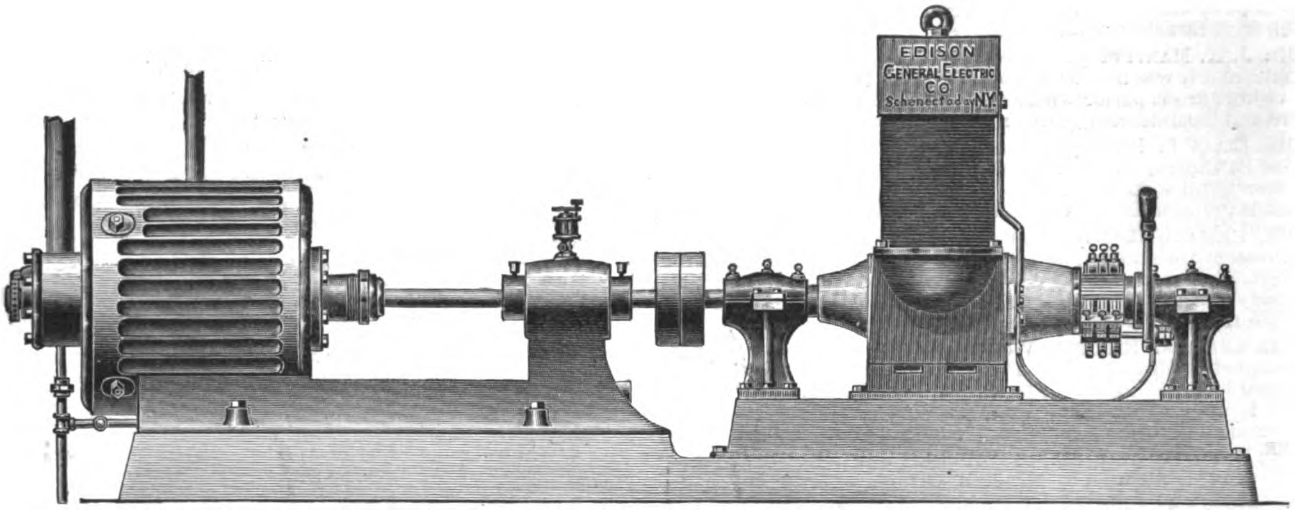


FIG. 1.—"AMERICAN" HIGH-SPEED ENGINE COUPLED DIRECT TO DYNAMO.

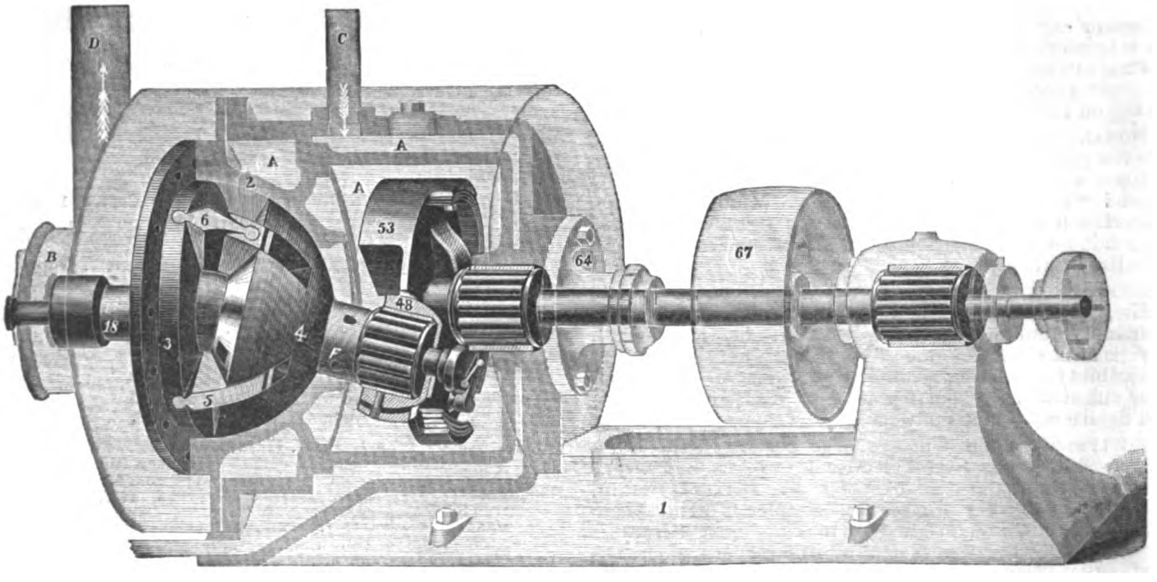
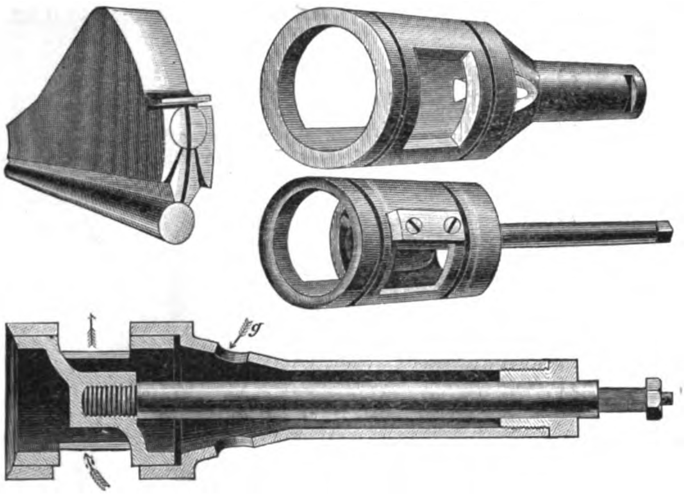


FIG. 2.—MECHANISM OF "AMERICAN" HIGH-SPEED ENGINE.

The general appearance of the engine connected to a dynamo is shown in Fig. 1. Although the engine has no dead centres, it is not a rotary engine in the true sense of the word. This will be recognized by an inspection of Fig. 2, which shows the outer parts of the engine in transparency and the working parts in full lines. In the same engraving, A is the steam chest, B the exhaust chest, C the live steam pipe and D the exhaust pipe. The cylinder is bolted to the bed, and projects into the steam chest, which gives it a live steam jacket. Radiation from the steam chest is prevented by by outer jacket. The cylinder has a circular opening through which projects the piston stem F. This opening admits steam against the back of the piston, its area being so proportioned as to balance the pressure of steam in the compartments at the face of the piston, thereby preventing friction between the piston and cylinder. The space between the piston and cylinder head is divided into four compartments by partition blades, 5 and 6, Fig. 2, one of which is shown in detail in Fig. 3. These blades have a pivot connection with the cylinder head, as shown in Fig 2, which allows them to accommodate the movements of the piston. The sides of the blades radiate from the centre of motion, and wear between them and their bearings against the piston is taken up automatically by a spring advancing them toward the follower pin, 18, Fig. 2. The latter is hollow, and connects the exhaust chest with the valve chamber in the piston, and also furnishes an abutment for packing strips in the ends of the blades. The opposite ends of the blades have packing strips also, to prevent leakage of steam from one compartment to another.

The crank disk and shaft are supported in frictionless roller bearings, as shown in Fig. 2, which work in steel bushings in the bed plate castings, the wear on the shaft being taken by steel sleeves. The piston stem bearing in the crank disk is of the same construction. All these parts are hardened and ground true.

The main and cut-off valves are shown in Figs. 4 and 5, and a section through both is shown in Fig. 6. They are located inside the piston, and bear against the follower pin, 18, Fig. 2, describing a circle at each revolution, together with the piston stem and crank disc, about the axis of the shaft, the radius of the circle decreasing towards the follower pin. The main valve also turns on its axis, being rigidly connected to the spherical bushing (48, Fig. 2), which is connected to the crank disc by a screw. This valve controls the admission of steam to the steam compartments, and also the exhaust. The cut-off valve controls the time of closing the steam port. Its stem extends through the main valve stem to the back of the crank disc, where it connects with the governor weight by steel rods *q* and carrier plate R, Fig. 7, the end of the stem being shown at *n*. Steam is admitted from the steam chest through the apertures shown in the piston stem F, Fig. 2, to the inside of the main and cut-off valves, at *g*, Fig. 6; thence, in the course indicated by the arrow, through a passage in the piston, shown above and to the right of 5 in Fig. 2, into one of the compartments, where it forces the piston away from the cylinder head. When the action of the cut-off valve shuts off the steam, the stroke is completed by expansion. As the valves revolve, the port of this compartment is put in communication with the exhaust port of the valves, and the exhaust passes out as indicated by the lower arrow in Fig. 6, through the hollow follower pin 18, Fig. 2, to the exhaust chamber B and pipe D.



FIGS. 3, 4, 5 AND 6.

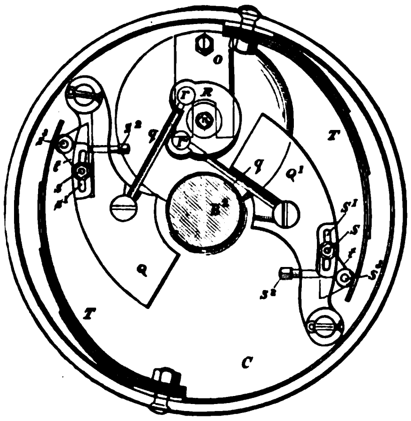


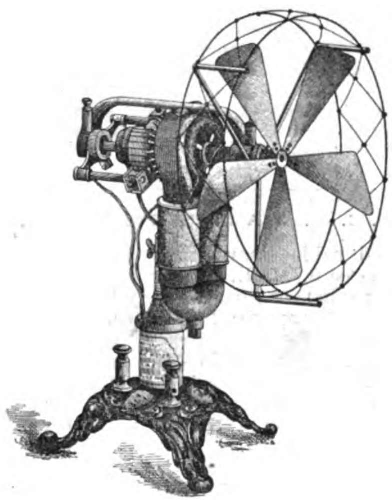
FIG. 7.

There is a diagonal partition in the cut-off valve, shown in Fig. 6, which separates the live steam from the exhaust. In the manner described, steam is admitted to one compartment after another until the stroke of revolution of the shaft is completed, the time of closing the steam port being controlled automatically by the governor so as to maintain a uniform speed under varying loads of pressures. The construction of the governor is clearly shown in Fig. 7. The main valve controls the admission and exhaust, which remain constant. The engine can be governed so as to run easily at any speed desired, up to a thousand revolutions per minute or more, the spherical segment which acts as a piston being so balanced as to insure smooth running and noiselessness. All moving parts except one bearing are lubricated with steam. The engine is compact and self-contained, taking up little room in proportion to power developed. It will work as well vertically as horizontally, and it may be hung overhead if desired, so as to be coupled directly to the main shaft. It may also be coupled to dynamos, circular saws, fans, blowers, etc. For marine use, elevators, etc., it is provided with reversing gear, and where a high degree of economy is desired, it is compounded.

THE CYCLONE ELECTRIC FAN.

THE accompanying illustration shows a novel style of fan designed by The La Boiteaux Electric Motor and Fan Co., of 376 Walnut St., Cincinnati, O. The chief peculiarity of these fans lies in their oscillating or rotary motion, by means of which the cooling current of air is equally distributed in all parts of a room. They are claimed to be entirely noiseless, and are especially adapted to large rooms used by many persons; the rotary fan being most suitable for offices, etc., while the oscillating arrangement has been found most convenient in hotel corridors, saloons, etc. Here the fan is placed upon the bar, or on a bracket on the wall, and moves slowly from side to side in a semicircle.

The rotary fan rests upon an enameled iron pedestal. While in motion, the motor and fan both revolve on their base at the slow speed of ten revolutions per minute, while the speed of the fan is 2,000 revolutions per minute. The double motion produces a cool wave of air, the effect of which can be readily felt at a distance of ten yards from the motor in all directions.

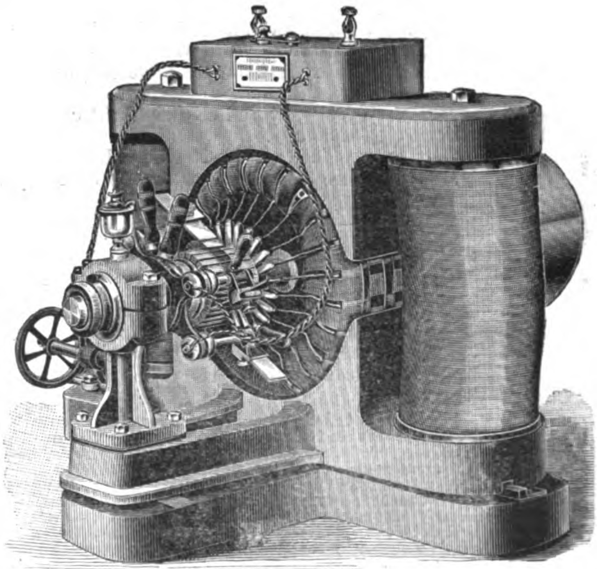


THE CYCLONE ELECTRIC FAN.

These devices are made in two sizes and can be attached to the ordinary incandescent circuit.

THE NEW DUPLEX ARC GENERATOR.

THE new arc generator built by the Duplex Electric Co., Limited, of Corry, Pa., possesses many of the general characteristics of their incandescent generators as will be seen by the illustration, which shows their 1,350 volt dynamo. It is of good design and simple in construction. This dynamo is a cool running, highly efficient series machine, and has an armature of the



THE NEW DUPLEX ARC GENERATOR.

closed coil type with 16 to 24 coils according to size, made so that any coil may be removed without interfering with the rest. The armature core is of the Gramme ring type, is constructed with special reference to perfect ventilation, and to prevent short circuiting.

The commutator is of hardened copper, thoroughly insulated with mica; in fact mica and wood are the principal insulators used throughout the generators.

The armature shaft is of best Bessemer steel and runs in carefully fitted phosphor bronze bushed boxes swiveled to insure alignment. They are made with wide fitted oil cups or self-oiling bearing to suit the purchaser. A hot bearing on these machines is unknown where ordinary care is used.

There are no rheostats or resistance coils used on this company's arc dynamo or on the incandescent generator, the regulation being accomplished on the arc dynamo by changing the position of the brushes on the commutator. When so ordered it is fitted with a simply constructed automatic regulator, which is sensitive to the slightest change of load and acts quickly and quietly by changing the position of the brushes.

This generator was designed by W. E. Cady, the electrician of the company, who has had a large experience in arc lighting machinery.

Every generator is thoroughly tested to its full load before leaving the factory, and they are made in any size ranging from 5 to 80 lights in 1,200 and 2,000 c. p. type.

N. I. R. SEAMLESS INSULATION.

The wires and cables manufactured by the National India Rubber Co., of Bristol, R. I., are now so well known and appreciated by the trade that this company is building a new plant which will increase its capacity four times.

Twenty-five years of experience with india rubber has given the company a thorough and minute knowledge of the manipulation of rubber in all its branches, and its application as insulation for electric wires is no new thing with them, for 18 years ago they applied rubber covering to wires for their own use, which wires are in use to-day with unimpaired insulation.

For a number of years Col. A. C. Eddy and other officers of the company have been experimenting with rubber insulation in conjunction with electrical experts, in the endeavor to produce a superior insulating covering.

The Massachusetts Electrical Engineering Co., of Boston, has been associated in these later tests. which have proved that only the best and most carefully-prepared rubber compound will make a good and lasting iusulation. The N. I. R. insulation possesses high insulating qualities, and is claimed to be less susceptible to the destructive influences of heat, cold, moisture and gases than that used by other companies.

Pure Lake copper and fine para rubber are used. The rubber covering is first pressed around the wire in a semi-plastic form, making a seamless covering, considered an important advantage over insulation having a seam on one or both sides.

It is then wound with rubber tape and covered with a braided weatherproof outer envelope. The whole insulation is then vulcanized. The wire is made with a black finish, or with a white fire-proof finish as desired.

Telephone and telegraph wires, switch cords, electric light and underground lead-covered cables are made in all the sizes called for, with a standard insulation resistance of 1,000 megohms per mile

A large quantity of their lead-covered electric light cables are in use in the New York city subways.

Mr. Samuel P. Colt is president of the National India Rubber Company, and Mr. F. S. Minott is manager of the wire department.

THE HEISLER ELECTRIC COMPANY.

The plant erected by the Heisler Electric Company, for the corporation of West Toronto Junction, Ont., Can., has been inspected and formally accepted by the town authorities. Mr. J. J. Wright speaks in the following terms of the installation, which certainly is an excellent endorsement of the work done by the Heisler Company:—

> "I have examined the plant installed by the Heisler Electric Company, and I find the work done in a thorough and workmanlike manner. The quality of the material used is good, the poles are of extra quality and well put up; in fact, the outside work reflects great credit on the men having had it in charge. The dynamo is well installed on a solid and durable foundation. and when examined by me was in thorough and satisfactory working order. The workmanship on the regulator is particularly admirable, and on trial performed its work well, keeping the current in both circuits perfectly even. The whole installation I consider first-class; in fact, it is a pleasure to be called in to pass judgment on work of this character."
>
> (Signed) J. J. Wright, Inspector.
>
> Toronto, Feb. 8th, 1892.

The Heisler Company also report the sale of a plant at Constantine, Mich., made through their agents, Messrs. Rheubottom & Bond, of Union City, who are doing excellent work in their territory, and are meeting with deserved success.

FRINK REFLECTORS.

In a letter to Mr. I. P. Frink, dated Columbus, O., of Jan. 6, 1892, Prof. B. F. Thomas. of the University, writes: "The lighting of the Senate and House Assembly rooms by electricity is giving most excellent satisfaction, and the reflectors furnished by you are much admired."

THE MESTON VOLTMETER SWITCH.

Fig. 1 is a prospective view of the apparatus, and Fig. 2 a diagram of the connections of the Meston voltmeter which is being manufactured by the Emerson Electric Mfg. Co. of St. Louis. The novel features consist in an improved form of self-adjustable contacts by means of which the connections are made with absolute certainty. The contact points are imbedded in the slate, so that their contact faces are flush with the slate. This arrangement avoids the possibility of short circuit. The connections are made by means of the brass studs which extend through the board, all connections being made at the back of the board. The switch is finely finished and elegantly designed, and is being well received by their customers.

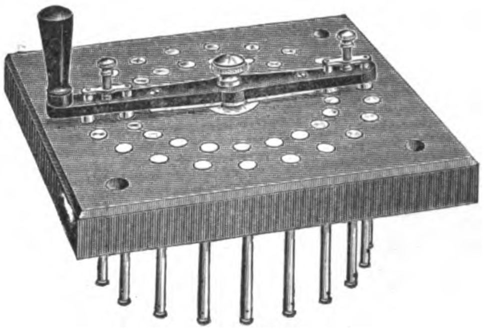


Fig. 1.

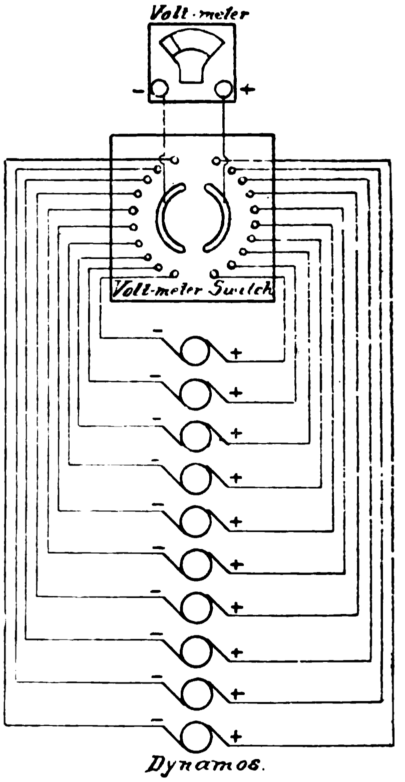


Fig. 2.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XIII. MARCH 9, 1892. No. 201.

THE TESLA MULTIPHASE CURRENT MOTORS.

BY

Albert Schmid

THE prominence which has been given to power transmission by multiphase currents in the experiments between Frankfort and Lauffen, seems to have led to the impression, even among those otherwise well informed, that this was the first example of this method of transmission. It may therefore be well to put on record the fact that in this country multiphase motors manufactured by the Westinghouse Co. have been in successful commercial operation for several years, and a three-phase power plant has been in daily service in the shops of the Westinghouse Co. at Pittsburgh for some time past, driving the shafting and machinery of the winding department.

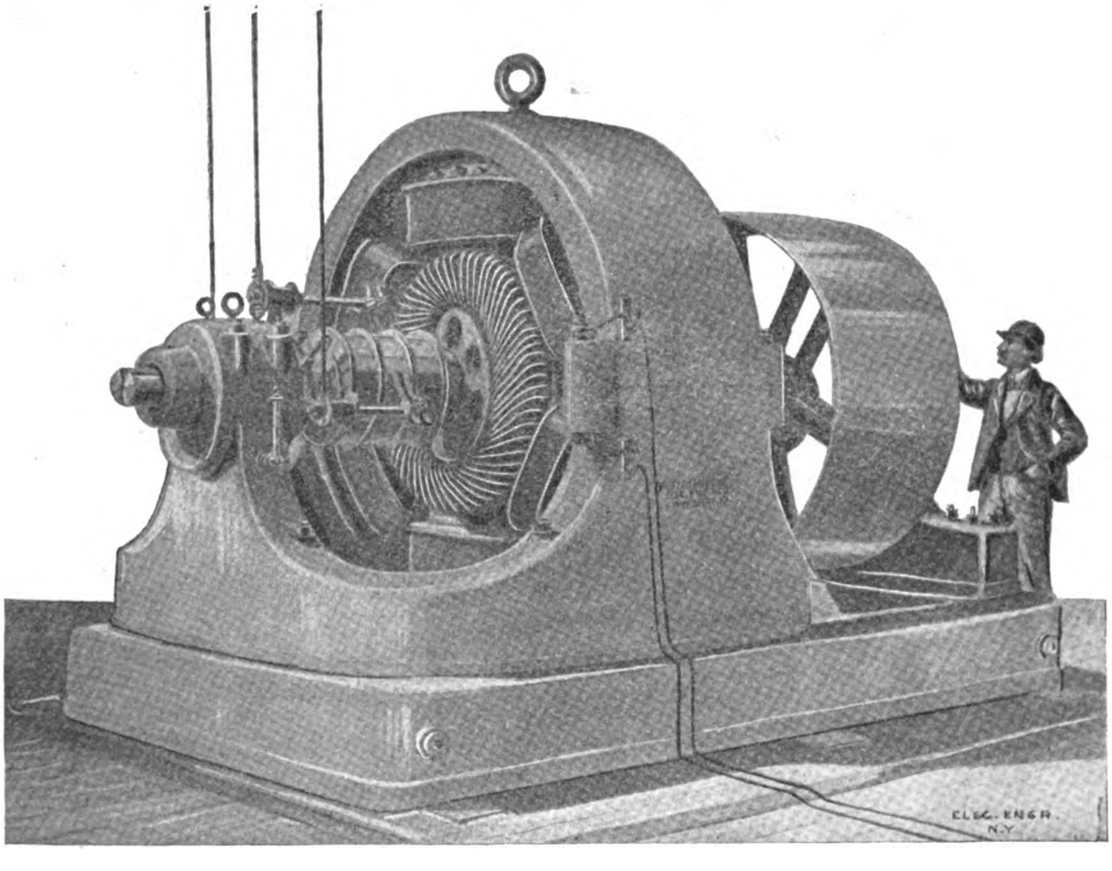

ELEC. ENGR. N.Y.

FIG. 4.—THREE-PHASE 1,000 H. P. TESLA ALTERNATING MOTOR.

As is well known, Mr. Nikola Tesla is the inventor of the multiphase motor, and his patents in this country are controlled by the Westinghouse Electric & Manufacturing Company, who have been quietly standardizing the different sizes and have, within the last year or two, placed a large number of them in service.

The generators for these motors are of the Westinghouse multipolar type with toothed, drum armatures wound to give currents of sixty or ninety degrees difference of phase. These machines, one type of which is shown in Fig. 1, are built either entirely self-exciting and self-regulating or separately-exciting and self-regulating. The machine shown is designed for 60 kilowatt capacity.

The motors are constructed with internal poles and grooved armatures. The larger motors have armatures with three collecting rings, and the fields are excited with direct current. The smaller ones have armatures wound with coils closed upon themselves, doing away with all collecting rings and commutators. The engraving Fig. 2, shows a 10 h. p. Tesla motor and Fig. 3 exhibits the armature removed from the enclosing field magnets. These multiphase motors are built in sizes of from 1 to 1,000 h. p.

A 1,000 h. p. three-phase generator or motor, for the same machine can be made either as a motor or generator, is shown in the engraving Fig. 4 and when run as a generator will give 150 amperes at 5,000 volts. In mechanical design this machine is similar to the multipolar direct current railway generators built by the Westinghouse Company. The armature is of the drum type with slots for the wire and is without bands.

With the Tesla multiphase system the power can be subdivided to any extent for motor or lighting purposes, and high pressures may be employed which can be reduced to whatever voltage is desired. The multiphase motors start under load, and run at constant speed. The smaller ones are made entirely alternating, and the larger ones are self-exciting after reaching synchronism.

As the starting torque with the Tesla multiphase motors is comparable with shunt wound direct current machines, they may be applied in every case where direct current shunt wound motors can be used. At starting, the direct current motors require dead resistance in series, which means considerable loss, but the alternating current motor has inductive resistance, and therefore the loss at starting is much less. Multiphase motors can be used for operating mines, factories, and street railways, and the generating station may be located wherever most convenient for obtaining the best results, and if the pressure is not over 5,000 volts, the motors may be supplied direct from the mains. The Tesla motor has a great advantage over other types of motors in that it requires no commutator, and consequently is sparkless. The motor may be boxed up, and kept free from dust and grit, and high pressures can be employed successfully. No starting resistance is required and the motor is small and compact, and requires no attention. Tests made at the Westinghouse Co.'s works demonstrate that the Tesla motors are fully as efficient as the best direct current motors.

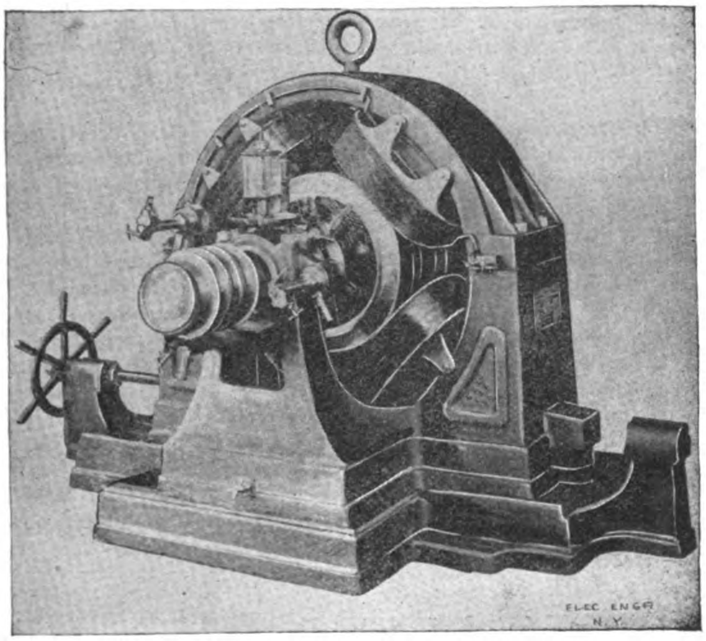
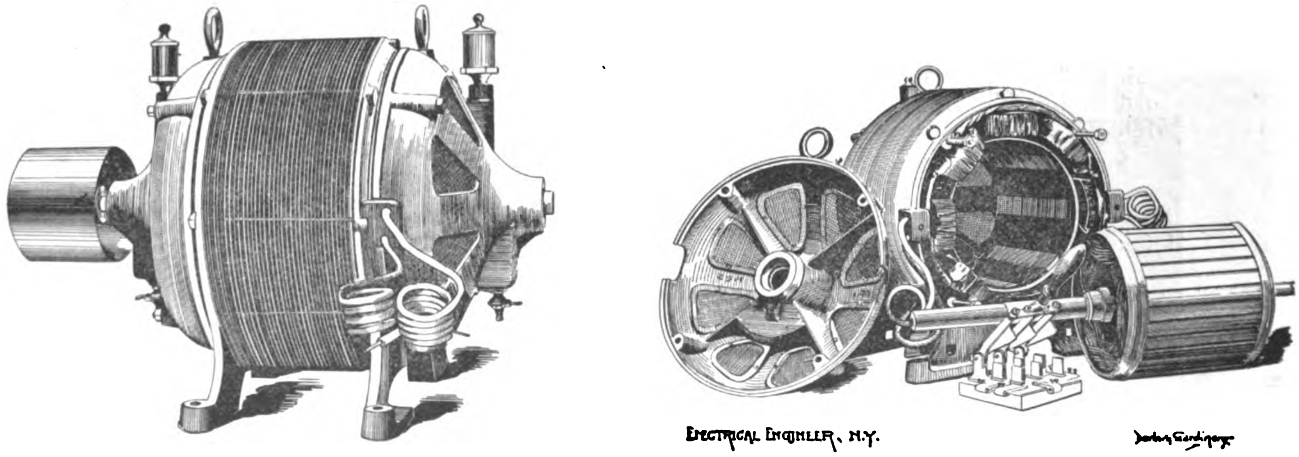


FIG. 1.—GENERATOR FOR OPERATING TESLA ALTERNATING MOTOR.


ELECTRICAL ENGINEER, N.Y.

FIGS. 2 AND 3.—10 H. P. TESLA ALTERNATING MOTOR.

THE COST OF STEAM POWER.

BY

Chas. E. Emery.

I HAVE had several requests, particularly from electrical people, to revise my paper on the "Cost of Steam Power," published in Vol. XII, *Transactions of the American Society of Civil Engineers*, (November, 1883), to correspond to conditions as they exist at present. I have concluded to make a comparison of the relative cost of power in engines of different kinds, using a 500 h. p. unit in each case, reckoned as effective on a shaft running at 200 to 350 revolutions per minute, such, for instance, as the main shaft of a high speed engine or the jack shaft of a low speed engine.

I would not propose to discuss at this time the difference in the cost of producing different quantities of power or to go into the capitalized value of steam power as in the former case, but simply compare the relative costs of the power when the interest on the cost of different types of steam machinery is balanced against the economical results due to such differences in type, considering also different prices for fuel and the conditions as to continuous or occasional use.

To accomplish this, I must have approximately the cost at which 540 to 550 indicated horse power steam plants of different kinds can be erected in connection with, say, two or more similar units in the same station with prices ruling as at present, and I will be greatly obliged to engine manufacturers if they will send to me at their early convenience the following information duplicated for each type of engine which they regularly manufacture, such, for instance, in a general way, as simple engines, condensing or non-condensing, fast or slow speed; compound engines, condensing or non-condensing, fast or slow speed; and triple compound engines, condensing or non-condensing, fast or slow speed.

1. Ruling price for 500 h. p. engine delivered at an average distance from the works, price to include condenser and air pump if engine is condensing.

2. Probable cost of foundations under average conditions.

3. Probable cost of connections to boilers, condenser, pumps, etc., including felting, painting and completion ready for regular use under average conditions.

4. Probable cost of belting to jack shaft if engine be of slow speed.

5. Probable percentage of friction of engine.

6. Probable percentage of friction lost in transmission to jack shaft.

7. Probable water per indicated horse power per hour under average working conditions at or near rated load.

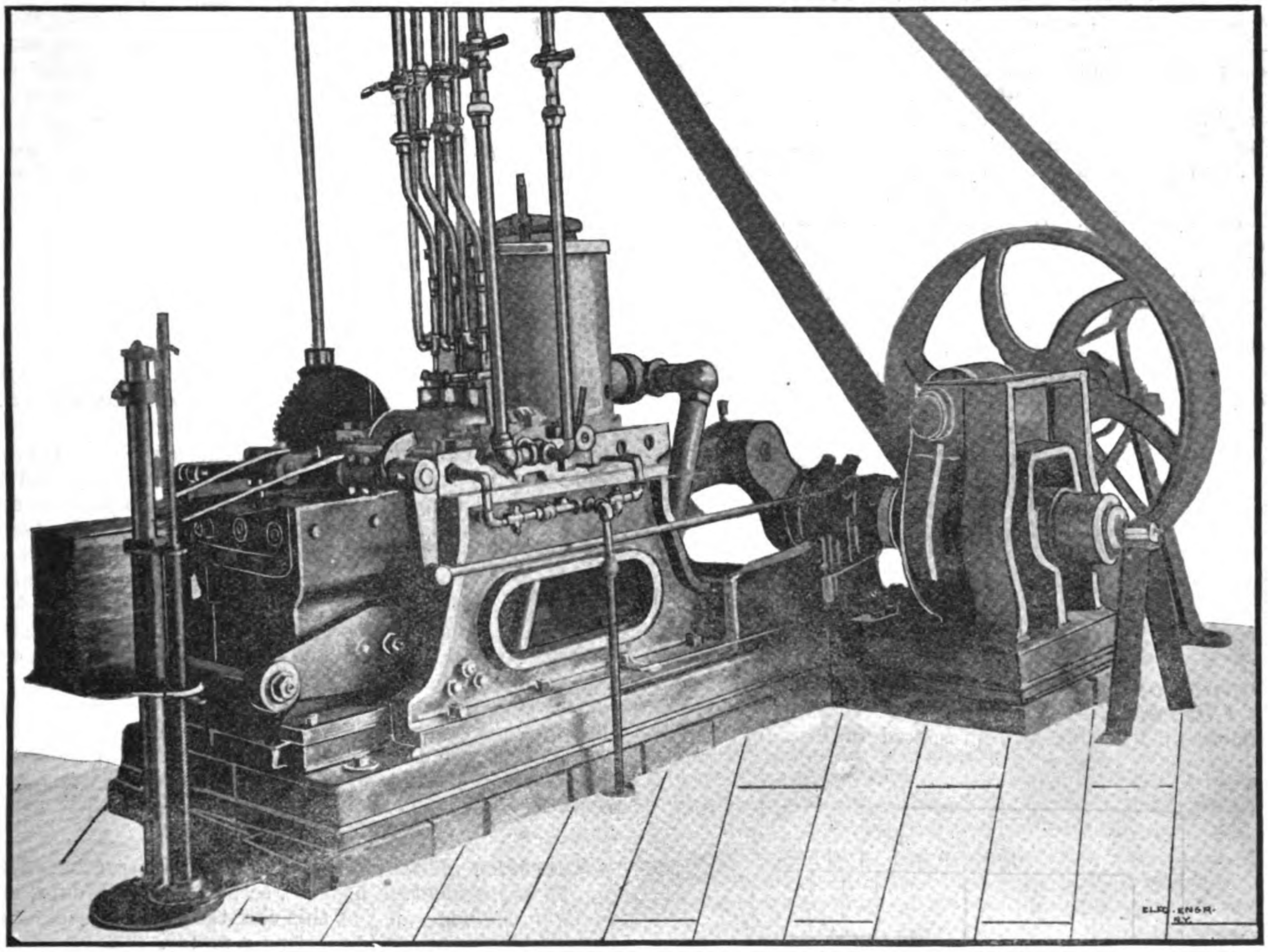
8. Probable cost of boilers, included setting, feed pumps and all connections ready for use, stating type of boiler proposed.

9. Probable cost for 100 surplus horse power of boilers.

10. Amount that should be allowed as a contribution toward cost of engine house, boiler house and chimney.

11. Probable cost of labor for 10 hours' operation which should be allowed for 500 h. p. unit in different parts of the United States.

12. Finally, state in a general way what information you have as to the ruling prices of coal delivered on the premises of consumers in different parts of the United States and its evaporative effect in the boilers which you refer to above.



MADDEN'S MACHINE FOR ROLLING STORAGE BATTERY GRIDS.

MADDEN'S MACHINE FOR ROLLING STORAGE BATTERY GRIDS.

WHILE much attention has been devoted to the chemistry of the storage battery and to some extent, also, to its mechanical construction, the fact remains that the methods originally employed are still largely retained in the manufacture of the cells. This is notably the case with regard to the making of the grids, which up to the present time have been cast in molds by hand, a tedious and expensive mode of operation. It was with the object of improving this branch of storage battery manufacture that Mr. A. F. Madden undertook the construction of an automatic machine for rolling storage battery plates on a commercial scale, for which a patent has recently been issued, and which we have had the pleasure of seeing in operation. Before entering upon a description of the machine we may premise that the inventor has been identified with the storage battery industry in this country since the beginning of its commercial history, having been one of the corps sent to England to observe the practice of the Electric Power Storage Co., of London, by its American licensee, the Electrical Accumulator Co, and having subsequently erected and superintended the well-known works at Newark, N. J. Mr. Madden's extended experience had convinced him that the best form of grid for the oxide of lead battery included the following characteristics: 1. Large area of contact between the conductor and active material. 2. Large area of surface exposed to the electrolyte. 3. Uniform distribution of the supporting conductor. 4. Perforations adapted to hold firmly the active material.

These requirements necessarily call for thin plates, containing a large number of comparatively small perforations, and considerable difficulty has been experienced in endeavoring to produce these commercially by the common method of hand-operated chills.

The machine designed by Mr. Madden is illustrated in the accompanying engraving. In brief, the process employed consists in rolling semi-fluid lead into a mold or "former" traveling back and forth under a roller, the grid being ejected at one end of the stroke. The turret shown at the right contains the lead and apparatus for heating. From below this, the lead is fed into an air-tight retort, closed at the bottom by a moving carriage containing the former. The latter is a masterpiece of mechanism, and though quite simple, would require an extended description to render its construction and operation intelligible. For the present purpose it suffices to say that, when under the retort, its movable divisions are lowered for the reception of the lead which is then crushed into it by the roller, and a reverse action at the other end of the stroke lifts the plate out.

An ingenious device is also provided for stacking the grids as they are delivered from the traveling carriage, as shown at the left.

One feature of Mr. Madden's grid is the shape of the perforations, the divisions between which, instead of increasing in thickness from their outer edges inward, have the same thickness throughout except at the edges, where a slight "burr," made in the manner described above, assists in holding the active pellets in place. The difficulty of freeing this form of grid from a mold has alone been an insurmountable obstacle in the way of casting it, but has been successfully met by Mr. Madden and forms one of the chief advantages of his machine.

After the grids leave the automatic machine they are passed through another machine which closes the perforations several thousandths of an inch all around by a slight "burr," and at the same time hardens them.

The machine is capable of turning out 5,000 grids in 10 hours, and produces not only a grid of high mechanical perfection but one of much tougher material than can be produced by casting. It is but the work of a few minutes to adjust the thickness of the grid made from one sixteenth to one-half inch. We may add that Mr. Madden's apparatus and patents are the property of Lloyd & Paxton, Limited, of this city, who are now carrying on an exhaustive series of experiments and tests, both here and abroad, in order to establish the superiority of these methods of lead battery construction.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—VI.

BY

Francis B. Crocker and S. S. Wheeler.

CHAP. IV.—*Continued.*

Dynamos on the Three-Wire System (Direct Current).—In the ordinary three-wire system for incandescent lighting as represented in Fig. 16, no particular precautions are required in starting or connecting dynamos. As a matter of fact the two dynamos are independent of each other and work on practically separate circuits. Dynamo 1 feeds the circuit formed by the mains marked + and N and dynamo 2 feeds the circuit formed by mains N and—. The "neutral" wire N merely acts as a common conductor for both circuits. The E. M. F. on each of these circuits should of course be kept constant at the prescribed voltage and therefore equal. The current on the two circuits or "sides" of the system as they are called, should be kept as nearly equal as possible by distributing the lamps equally between them. Any difference in current either way is carried by N. One dynamo may be run alone on one side of the system and the only effect of throwing on the other dynamo is to reduce the "drop" or fall of potential on the wire N. In fact if the load is equal on both sides there is practically no current or drop in N. If dynamos are put on the circuit in parallel also—for example, two in parallel on each side of the system, making four dynamos in all, then the machines on each side are managed simply as dynamos in parallel, as previously described. In starting up dynamos on the three-wire system, it is better to start one machine at a time and get that working properly as already described, and then put on a machine on the other side of the system to keep the two sides even. The addition of dynamos in parallel on each side should also be done singly just as on a simple two-wire circuit.

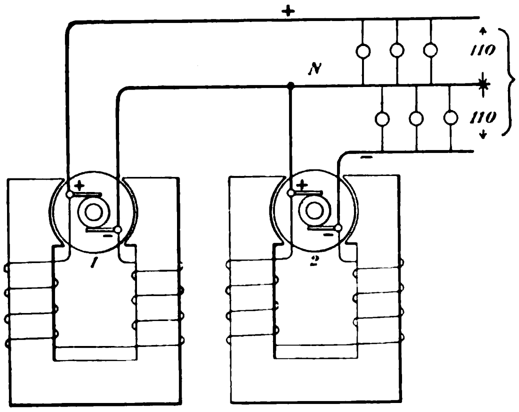


FIG. 16.—THREE WIRE SYSTEM.

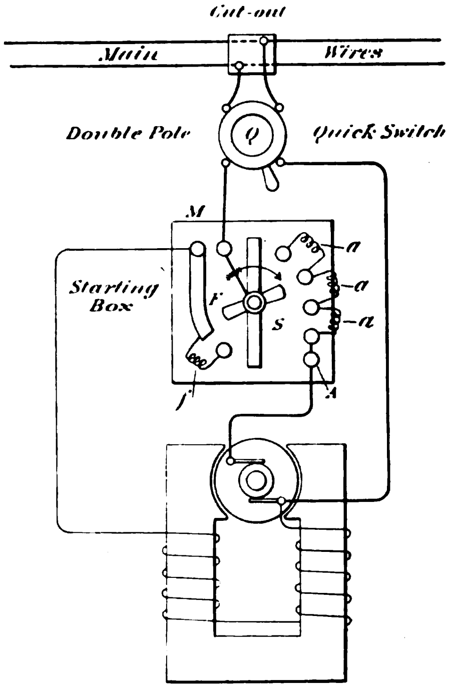


FIG. 17.—SHUNT MOTOR ON CONSTANT POTENTIAL CIRCUIT.

Starting Motors.—The general instructions relating to adjustment of brushes, screws, belt, oil cups, etc., given in the beginning of this chapter should be carefully followed preparatory to starting a motor.

The actual starting of a motor is usually a simple matter since it consists merely in operating a switch, but in each case there are one or more important points to consider.

Constant Potential Motor (Shunt Wound).—A motor, to run at constant speed on a constant potential circuit (a 110-volt incandescent lighting circuit, for example), is usually plain shunt wound. This is the commonest form of stationary motor. The field coils are wound with the right size of wire to take the proper magnetizing current as in the case of a shunt dynamo, and, since the potential is constant, the field strength is constant. Shunt coils must not be used however if the potential is more than 5 per cent. higher, or 20 per cent. lower, than that for which they are intended, as stated elsewhere.

Throwing the field into circuit is therefore simple, but the current in the armature in starting is quite difficult to take care of, because the resistance of the armature is very low in order to get high efficiency and constancy of speed, and the rush of current through it in starting might be ten or more times the normal number of amperes. To prevent this excessive current, motors are started on constant potential circuits through a rheostat or "starting box," containing resistance coils as represented in Fig. 17. The main wires are connected through a branch cut-out (with safety fuses) and preferably also a double-pole quick-break switch Q, to the motor and box as indicated. When the switch Q is closed and the arm S is turned to the right, the field circuit is closed through the contact strip F and the armature circuit is closed through the resistance coils *a*, *a*, *a* which prevent the rush of current referred to. The motor then starts and as its speed rises, it generates a counter E. M. F. so that the arm S can be turned further until all the resistance coils *a*, *a*, *a*, are cut out and the motor is directly connected to the circuit and running at full speed. The arm S should be turned slowly enough to allow the speed and counter E. M. F. to come up as the resistances *a*, *a*, *a* are cut out. The arm S should positively close the field circuit first so that the magnetism reaches its full strength (which takes several seconds) before the armature is connected.

The object of the resistance *f* is explained under "Stopping Motors." The coils *a*, *a*, *a*, are made of fine wire which can only carry the current for a few seconds in a "starting box;" but if the wire is large enough to carry the full current continuously it is called a "regulator" or rheostat because the arm S may be placed so that some of the resistances *a*, *a*, *a*, remain in circuit and they will have the effect of reducing the speed of the motor.

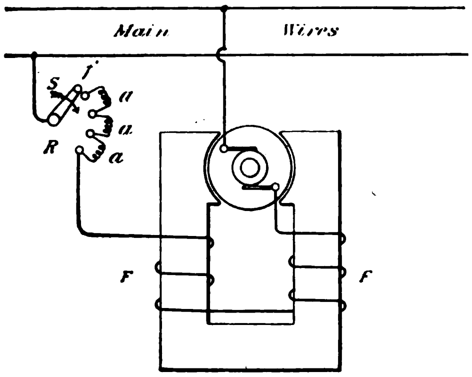


FIG. 18.

Constant Potential Motor (Series Wound).—The ordinary electric railway motor in the 500 volt trolley system is the chief example of this class. Motors for electric elevators and hoists are either of this kind or the previous one. A similar rush of current tends to occur when this type of motor is started as in the case just described, but it is somewhat less because the field coils are in series and their resistance reduces the excess. The essential connections in this case as indicated in Fig. 18, are very simple, the armature, field coils F F, and rheostat, all being in series and carrying the same current. The series wound motor on a constant potential circuit does not have a constant field strength and does not tend to run at constant speed like a shunt motor. In fact it will "race" and tear itself apart if the load is taken off entirely, it is therefore only suited to railway, pump, fan or other work where variable speed is desired and where there is no danger of the load being removed or a belt slipping off.

Constant Potential Motor (Differentially Wound).—This is a shunt wound motor with the addition of a coil of large wire on the field and connected in series with the armature in such a way as to oppose the magnetizing effect of the shunt winding.

It was formerly much used to obtain very constant speed, but it has been found that a plain shunt motor is sufficiently constant for almost all cases. The differential motor has the great disadvantage that, if overloaded, the current in the opposing (series) field coil becomes so great as to kill the field magnetism and the armature slows down or stops and is liable to burn out; whereas a plain shunt motor can increase its power greatly for a minute or so when overloaded and will probably throw off the belt or carry the load until it decreases to the normal amount.

THE RIES REGULATING LAMP SOCKETS.

BY

W. J. Hammer

MUCH has been said of late in reference to the utility of the reaction-coil principle when applied to the regulation of independent incandescent electric lamps operated by alternating currents, as exemplified in the very ingenious, but up to the present, imperfectly understood, regulating sockets recently devised by Mr. Elias .E Ries of Baltimore, and in view of the remarkable claims for this invention and the interest which it has attracted in electrical circles the writer takes pleasure in bringing the matter before the public through the courteous permission of Mr. Ries who has extended to him facilities for making a thorough investigation of its merits. The socket was first shown publicly at the Montreal Convention of the National Electric Light Association, and it is doubtful if any feature of the exhibition at that time attracted more general interest.

Many attempts have been made to produce a satisfactory and economical method of turning down incandescent lamps. The earliest experiments were made by Mr. Edison and others, in which carbon rods, plates, coils of German silver, platinum, iridium and other metals were introduced in the series with the lamp, thus causing considerable of the energy cut out of the lamp to be dissipated as heat, and none of these methods has proved efficient or of commercial value.

Lamps were also constructed containing two or more carbons which could be connected in series or multiple to vary the candle power, and a lamp invented by the writer many years ago contained a number of carbons of various candle power which could be separately introduced into the circuit to give any degree of light desired.

Inventors have also endeavored to construct an economical device for controlling the light without the introduction of resistance, as the value of such a means of regulating the incandescent light has always been appreciated, and one of the principal claims of gas engineers is that the incandescent lamp could not be turned up and down, certainly not with the efficiency which existed in the gas system. Mr. Philip Diebl has presented the writer with a complete set of the experimental steps in his alternating current lamps which show a very interesting stepping-stone in this direction.

Before proceeding further let me say a few words upon the principle of the reaction coil which has been applied in various ways by Thomson, Shallenberger, Ries and others, and referred to in the works of Fleming, Hopkinson and others. A reaction coil of the most simple type is constructed of one coil of a conductor wound around a magnetizable core; probably the simplest form employed commercially is the ordinary spark coil used in electric gas lighting. A direct current passed through such a coil magnetizes the core and sets up lines of force which maintain the same direction so long as the current is continued;

there is a slight heat also produced in the coil due to its ohmic resistance. Naturally, reversing the direction of the current reverses the polarity of the magnetized core. It does more than this, however. This reversal of current and consequent disturbance of the magnetic field produces practically a transformer with but one coil in which appears the impressed E. M. F. and the counter E. M. F.; the counter E. M. F. retards the primary current through the coil, producing the "choking effect" as it is called. In employing a continuous or direct current the counter E. M. F. is produced only at the instant of closing of the circuit or reversing the direction of the current, but with rapid alternating current the counter E. M. F. becomes as constant as the impressed E. M. F. of the primary current, and in the Ries socket the ratio of these may be varied, thus controlling the candle power of each light independently and without resistance, and, as shown by Fleming and others, with an infinitesimal loss.

When the difference between the two E. M. F.'s is greatest, as determined by the position of the regulating key, the light is at its maximum, and when this difference is such that the two E. M. F.'s nearly approximate each other, the filament glows at its minimum point of light. One of these E. M. F.'s being variable with respect to the other, it will thus be seen that lamps of any desired voltage less than that of the supply circuit can be safely burned at their normal candle power, and that standard lamps of any given voltage or resistance that are supplied with a normal E. M. F. of, say, 50 or 55 volts, can be burned at any degree of brilliancy required all the way from a barely perceptible glow up to their maximum candle power. The most remarkable part of this method of electric lighting is its extremely high efficiency and the self-contained simplicity of the apparatus by which it is carried out. The writer has in his possession sockets of this character in which the two E. M. F.'s so nearly balance each other as to extinguish the light without even the necessity of opening the lamp circuit, the amount of energy consumed in maintaining this balance being so slight as to be measurable with only the most sensitive instrument. I have personally placed lamps in series with a sensitive amperemeter and varied the current from 3½ amperes to one-tenth of an ampere as perfectly as gas is turned up and down, the amperemeter indicating the variation in current precisely as if it were a fluid or gas which was being turned on or off.

The writer has had the privilege of witnessing some ingenious and beautiful effects produced by Mr. Ries which show the facility with which this socket lends itself to modifications, adapting it to special requirements. For example, one is enabled to operate a 110-volt Edison lamp on a 55-volt Westinghouse alternating circuit, or to operate a 55-volt lamp on a 110-volt circuit, and at the same time to produce all the variations in light from zero up to full candle power. All this, it should be noted, is produced with practically no loss of current and entirely by the reaction of the current upon itself; no moving apparatus or outside connections whatever, other than the usual circuit adjustments on ordinary lamp sockets being employed.

The Ries socket comprises an enclosing shell of neat design, and but slightly larger than the well-known types of "make-and-break" sockets now in use, and contains a small counter E. M. F. generator or reaction coil, or choking coil, of peculiar construction, which, however, may be of any desired type so long as the general conditions to which it owes its high efficiency are adhered to. This coil consists of a small, thoroughly laminated, closed iron core built up of numerous rings of specially prepared iron, the whole being compressed, taped and wound at one operation with a special silk-insulated cable containing a number of separately insulated copper wires of different diameter, varying according to the maximum current to be carried by each, the ends of these wires, after the cable is wound, being connected in series with each other by contact pins arranged in the path of an arm attached to the operating key. The interior connections are such that when the socket is wired up more or less of the wire composing the coil is in series with the lamp filament, according to the position of the operating key, and the length of wire thus included determines the amount of counter E. M. F. generated. Or, to express it in another way, by cutting out turns of the coil the self-induction is lessened and more current is allowed to flow through the wire to the lamp. The light is divided by this socket into seven different stages, and the potential difference between each contact pin being but one-seventh that of the total difference of potential on the mains, the flashing at these points is very slight, no snap action or other complicated make-and-break mechanism being employed. The entire arrangement is one of great simplicity and compactness, requiring no more attention or knowledge in operation than the turning on and off of an ordinary gas burner, which in this respect it closely resembles.

When the lamp is burning at full candle power, practically all of the coil sections are cut out; that is to say, when lamps of the normal voltage of the supply circuit are used. Usually, however, it is advisable to employ lamps of somewhat lower voltage, so that if for any reason the pressure on the circuit falls below its normal, the lamp may be turned up so as to still give its maximum candle power, a feature not at present attainable with the ordinary type of sockets in general use. When the full amount of light is not needed, the counter E. M. F. generated is increased by the cutting in of additional coil sections, thereby reducing the flow of current through the lamp and causing the latter to glow at a lesser degree of brilliancy, and at the same time materially reducing the strain upon the lamp filament. The winding of the socket is so arranged that when the light is turned down to its lowest stage the filament is just visible in the dark, so as to readily enable one to locate the position of the lamp upon entering a room and to turn it up to the desired point without having to first feel around for it among the electrolier or other fixtures of which it forms part. By the use of this socket one may have some lights in a room burning at low brilliancy and others at a lower degree of incandescence, thus distributing the light exactly where it may be wanted, instead of being compelled to burn the lamps full on when but little light is needed.

The saving in current that this socket is capable of effecting is almost beyond the belief of one who has not tried it, and actually surpasses everything that has yet been claimed for it in this direction. The writer has had occasion to thoroughly investigate this point recently, and has found that a 25 c. p. 50-volt lamp, which consumed 75 watts when burning in one of these sockets at full candle power, consumed, together with the socket, just 3 watts, or only *one twenty-fifth* of the total energy, when burning at a low degree of incandescence equal to that produced by a net potential difference of 10 volts at the lamp terminals. This means that it is possible to burn twenty-five lamps at a visible degree of incandescence by means of this socket with the same amount of electrical energy that a single lamp would consume burning at its normal candle power. Of course, the light given by the lamp at this point, while sufficient to render the filament itself visible at a distance, was altogether too small for the purpose of affording outside illumination, and therefore this cannot be taken as a criterion of the average consumption of current in practice, which would be very much higher, especially as the lamps are usually burned at nearly or full candle power by the consumer when in actual service for furnishing light; the intermediate stages being used for the most part only for all-night service in sleeping apartments and other places where, under the existing condition of things, the incandescent light, if used at all, would be turned off altogether. The writer believes the Ries regulating socket marks a radically new departure in the method of controlling the incandescent electric light.

AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—VI.

BY

Mary A. Henry

(*Concluded.*)

STILL something more do we learn from Henry's paper, taken this time in connection with other evidence, in regard to the date of his researches in the induction of electrical currents. This something is very important. The paper closes with what Henry calls "Electrical Self-Induction in a Long Helical Wire," which we have already noticed as constituting the discovery of the "extra current." Now the date of this discovery is exactly fixed for us. Henry, in the *Smithsonian Report* for 1857, p. 106, refers to this identical paragraph, in some testimony in regard to what he did for the telegraph. He says: "I had no idea at the time of abandoning my experiments for the practical application of the telegraph. *Indeed my experiments on the transmission of power to a distance were superseded by the investigation of the remarkable phenomenon, which I had discovered in the course of these experiments, of the induction of a long wire upon itself, and of which I made first mention in a paper in Silliman's Journal in* 1832, *Vol.* XXII;" this paper is the one we are discussing. Notice how distinctly Henry says that "the remarkable phenomenon" was discovered in the course of the "experiments on the transmission of power to a distance." We have only to find these experiments to find our date. They are recorded in *Silliman's Journal* of January 1st, 1831. They were made, as the reader may see if he will find the paper and study it carefully, in 1829, interrupted by the need of the room for the use of the Academy; therefore at the close of the vacation in August, 1829. The discovery of the extra current was made in the course of them, and so is fixed for us its date, viz., 1829.

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JOSEPH HENRY.

Another incidental reference Henry makes in the same Smithsonian paper,[1] to the investigations induced by this discovery of the extra current. He says: "After completing the investigations above mentioned" (that is, the experiments upon the transmission of power to a distance) "I commenced a series of experiments upon another branch of electricity." The experiments upon transmission of power to a distance were made, as we have seen, in 1829, in the latter part of the August vacation; this new series which followed them must have been in the vacation of 1830, for only in vacation time could Henry pursue any regular investigation, every day between being filled, as we know, from early morning until night with college duties. There is nothing in Henry's work at this time which can be called "another branch" unless it is magneto-electricity. The brilliant spark of the extra current gave rise to this new series of experiments of 1830, and in this series must have been included the one upon which we have founded our paper. The one phenomenon led to the other, and so we bring again our experiment to 1830, and show also that there were earlier experiments of a like order.

We trust the reader will not forget that the points we have been touching thus one by one are to second the words which fell from the lips of Henry in the happy confidence of home and friendship.

One thing more and we will close our story. We would ask the reader to notice how distinctly in this paragraph about the electrical self-induction in a long helical wire, Henry classes this phenomenon with that of magneto-electricity. Not only does he place them thus together in his paper as of the same order, but later, he writes to Dr. Bache: "I have been much engaged in repeating my experiments on the long and short conductors. The phenomenon, as I suggested in *Silliman's Journal*, is intimately connected with magneto-electricity, if not identically the same. The influence of coiling the conductor I have clearly made out, and can produce with a large coil and one plate of my battery, shocks which may be felt at the elbows. The presence of soft-iron has little effect in producing the spark." And again he writes: "I would infer . . . that effects . . . attributed to magneto-electric action are chiefly due to the reaction on each other of the several spires of the coil which surround the magnet". That the two phenomena are the same, is, as we have said, now recognized by the science of the day. A representative of it says: "The extra current is generated by relative "movement of conductors and lines of force" (the lines "moving in this case). This is precisely the essence of "the great discovery of magneto-electricity, and identically "the principle of the modern dynamo. The great mind of "Henry logically evolved the second from the first, and "recognized their identity. This is shown by the sequence

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[1] *Smithsonian Report*, 1857, p. 111.

"in the order of his experiments and published statements. "*The very fact that Henry, at this extremely early date,* "*recognized the relation of these phenomena, produced by* "*the same cause, shows how complete and wonderful was* "*his familiarity with this abstruse subject, so difficult of* "*comprehension even at the present day.*" It is only very recently that the two phenomena have come to be considered the same; the scientific world has only just come to the point where the youthful Henry stood so long ago.

Let us now review our position. *The limit of earliness for Faraday* in the great discovery of magneto-electricity is August 29–30, 1831, when with his ring he is asking the question of Nature. *The limit of lateness for Henry* is August, 1831, since his paper tells us his analogous experiment was made *before* seeing the notice of Faraday of April, 1832; therefore before the close of August, 1831, when Henry's experiments stopped not to be resumed until the following June.

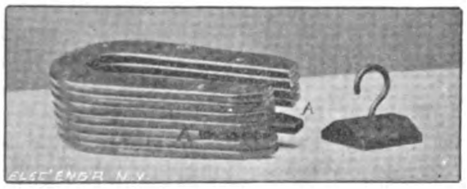
2. Into the very last day of August, 1831, must we squeeze Henry's experiment in order to give Faraday priority, and if at work on that day, which is not probable; *we know he is doing something else*, viz., making a large magnet to pursue on a large scale investigations induced by the discovery which has already been made.

3. The magnet used was the one of 1830, and in 1830 Henry is making a series of similar experiments.

Finally. The especial experiment we have been studying as the initial experiment of the great discovery is hardly so with Henry; it is but the natural sequence of other and earlier investigations. As early as 1829 Henry obtained sparks by what he considers a phenomenon of the same kind.

And so we claim that Faraday cannot in justice be said to have made the great discovery of magneto-electricity until September 24, 1831, more than three weeks after Henry's experiments had ceased; that Henry's magnet asked the great question certainly earlier than Faraday's ring—and to give Henry priority it matters not how much earlier, since it was earlier, that it did so a year earlier, in August, 1830, and that two years earlier, in August, 1829, Henry had obtained sparks from, and recognized a similar phenomenon now declared by science to be the same.

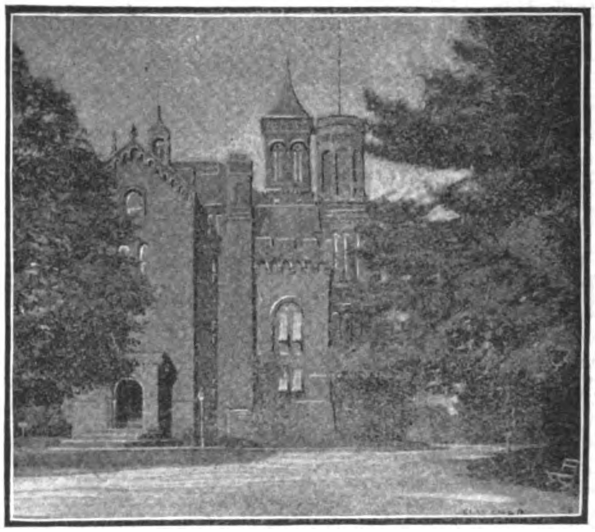
If it seems strange that Henry allowed his valuable discoveries to remain so long unpublished, his busy life should always be remembered. We find him in all his after years equally careless in securing to himself the credit of his labors. In Princeton he had hardly more time than in Albany, and in Washington the world-wide operations of the Smithsonian Institution were even more inimical to scientific research than the duties of college or academy. Recorded in his laboratory books are many researches, never given to the public, for the want of the precious boon of time. Then when the coveted time came, Henry was like the explorer, who fixes his eager eyes on distant hills; more anxious to discover new lands, than to make good his right to those he has passed over. Finally, Henry was of an unusually generous nature. Thought of himself was the last thing to come to him in every action. That he appreciated and valued the credit due him was most natural, but this was far more than secondary to the single steady aim of obtaining new truths from nature that might in some way be of use to the world.



PERMANENT STEEL MAGNET USED BY HENRY IN INDUCING ELECTRICITY. THE COIL WAS WOUND AROUND AN IRON BAR BRIDGING THE POLES OF THE MAGNET AT A. A.

Did Faraday ever acknowledge his indebtedness to Henry's magnet for the part it plays in the great discovery, and later in those other great discoveries of diamagnetism and the magnetic effects on polarized light? A certain general tribute he pays to the magnets, other than their use in his "Experimental Researches," but we cannot think him lacking in appreciation of Henry, since there comes from him the enthusiastic expression:—"Henry is by far the greatest man of science America has produced since the days of Franklin." The two men learned to know and love each other in 1836 when Henry went to London.

Our story is ended; yet for a moment would we ask our readers to turn back to those experiments on a large scale Henry was making in August, 1831. Let us look again at the big "magnet, weighing 101 pounds" with a great "reel" for an armature, wound with a mile of wire, and knowing from Henry's paper that he had found out that merely to move the armature before the poles of the magnet was to produce a current of electricity in the wire; let us also look again, on the same page, at the picture of the modern dynamo, to note its main features, viz., a "big magnet" (Henry's electromagnet unchanged in principle, since he gave it to the world so long ago), and a reel armature, wound with wire, revolving between its poles. It is curious, in those August days of 1831, to see Henry so literally making a dynamo. He had made his smaller magnet, with a wire around its armature, move a needle 40 feet distant; this larger affair was to produce power capable of work; of what kind and extent of work it could be made capable, we in these days know well. Around the room in which he was working were the wires of the telegraph, and in his possession was the first electric motor, a combination made by him of his electromagnet and permanent magnets. With these three prizes in his hands, why did he not leave the Albany Academy and all its arduous duties? There were many reasons, but we give only the one pre-eminent with Henry. He would have had to leave not only the Academy but the great field of original discovery to introduce these things into practical use. The work required for such an undertaking, very different from that of scientific investigation, would have involved years of the time so valuable to Henry. Fortune offered her wealth to the young man if he would, as it were, stop to dig up the gold he had found, instead of seeking further for new treasure, but Henry's answer was, "My ambition is to add to the sum of human knowledge by the discovery of new truths which may be of some use to the world; the practical application of these I desire to leave to others." He might at least have patented his prizes, so as to receive



EASTERN WING, SMITHSONIAN INSTITUTION, WASHINGTON, D. C.

from them some benefit, but when his friends urged him to this his reply was, "What I can give to the world I desire to give freely." The only reward he received for his gifts was the one he desired. At the close of his days he said "I have had a happy life; I hope I have done a little good in it." We have wandered far from the discovery of magneto-electricity, let us return to it and close our story.

A brilliant spark flashes in young Henry's studio in 1829, to betray to him, in the extra current, the secret principle of the dynamo. To-day, this potent instrument enters factory and home, in a thousand ways the effectual slave of man, while tired horses rest in their stables, as it drives our cars to and fro. High up in our city street, when night comes down, the electric spark, leaping from wire to wire, burns a carbon point and turns our darkness into day. The lightning, forced to be man's messenger in the telegraph, compelled to do his work in the electric-motor, has been caught in its free play from cloud to cloud to do this service; even as the steed once coursing in wild freedom over the plain now threads with patient feet the medley of rolling wheels on the pavement below. To tame the intermittent flash into this steady cheering ray, Henry developed the magnetic force, and Faraday and Henry both set electricity and magnetism to work, the one producing the other; but that they can do so anywhere is due to the discovery of Henry, which made it possible to call them into conjunctive action *through any length of wire.* Each year, each month, each day almost, adds some new blessing to the world, through the great discovery of the *identity of electricity and magnetism.* Let England sing her hymn to Faraday; he well deserves it; but let not America forget the meed of praise due her Henry. His is surely not the second place in the great discovery.

STATUE OF JOSEPH HENRY, WASHINGTON, D. C.

THE SEQUENCE

Of Discoveries Connected with and Accompanying the Discovery of Magneto-Electricity.

1829	The making of the powerful intensity magnet, capable of excitation at a distance; the magnet of the telegraph of to-day. The making of the quantity magnet. The discovery of the law embodied in Ohm's theory of the relation between the electric flow and electric resistance. The discovery of the combination rendering possible the telegraph. The making of the first magneto-electric telegraph. *The discovery of, and sparks obtained from, the extra current,* now considered the same phenomenon as that of magneto-electricity.	BY HENRY.
1830	The perfection of the quantity magnet, the stepping stone for both Faraday and Henry in the discovery of magneto-electricity. *The discovery of magneto-electricity.*	BY HENRY.
Aug. 1831	The making of the first electric motor. Experiments on a large scale with magneto-electricity; the making of a dynamo.	BY HENRY.
Aug. 29-30, 1831	Experiment with Henry's magnet in the form of a ring, in which the phenomenon of magneto-electricity was obtained but not fully recognized.	BY FARADAY
Sept. 24th, 1831	Experiment with a bar magnet, viz: *The discovery of magneto-electricity.*	BY FARADAY
Oct. 17th, 1831	Experiment of inserting cylindrical bar into the end of a helix cylinder, usually given in text books as the one by which the discovery of magneto-electricity was made.	BY FARADAY

AN INTERESTING ELECTROLYTIC PHENOMENON.

In a communication recently made to the Académie Royale de Belgique, Prof. Lagrange and M. Paul Hoho describe some experiments made by them on a luminous and calorific phenomenon which takes place under certain conditions when a current is passed through an electrolyte. The phenomenon was first observed in 1844 by Foucault and Fizeau, and has subsequently also been investigated by Righi, Colley, Planté and others. Prof. Lagrange and M. Hoho employed in one experiment a 10 per cent. solution of H_2SO_4, the positive electrode being of copper with 180 square cms. in the liquid, the negative electrode being a copper wire ½ mm in diameter plunged into the electrolyte to a depth of ½ mm. Current was obtained from a battery of accumulators. At first only the ordinary phenomenon of electrolysis are observed; then, as the volts are increased, bubbling and boiling occur at the negative electrode, next intermittent arcs take place between wire and liquid, finally a luminous cylinder is formed having the copper wire for axis, the current then becomes steady, and the resistance very high. On plunging the wire further into the liquid, this series of phenomena can be reproduced. Much the same effects were produced with platinum, zinc, tin, iron, steel and carbon electrodes of different diameters, with sulphuric acid solutions of different strengths, and with a chloride of sodium solution. The production of the luminosity is accompanied by an abnormal resistance which is localized round the negative electrode; with electrodes 29 cms. apart, practically all the fall of potential takes place within 5 mm. of the negative electrode. The shape of the negative electrodes appears to have but little influence. Luminous effects can be made to occur also at the positive, but with some difficulty. It is, however, impossible to produce luminosity at both poles at the same time.

GALVANIZING IN THE COLD.

The London Metallurgical Company are introducing a new process of galvanizing, which seems to have several advantages over the older process. The process appears to be one in which zinc is deposited from its solution in the cold on the wire or sheeting to be coated, and the inventors claim that in this way a more even and uniform thin coating of the protective metal is obtainable, while at the same time, in the case of wire, the tensile strength is not diminished, as occurs when thin iron or steel wires are galvanized by the common methods of steeping in molten zinc. At the ordinary temperature, too, there is no appreciable tendency to form a zinc iron alloy, which causes a considerable waste of zinc in addition to the reduction of strength already pointed out, and may be regarded as a further defect in the present system. Comparative tests on the hardness of the coating on iron sheeting by means of the sclerometer also show that a plate galvanized by this process has a harder surface than that obtained by the ordinary hot method of galvanizing.

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Study science with earnestness—search into nature—elicit the truth—reason on it, and reject all which will not stand the closest investigation.—Faraday.

A FEW FIGURES ON UTILIZING NIAGARA.

ONE of the most interesting episodes in connection with the recent Buffalo Convention was the visit to the Hydraulic Power Co.'s works at Niagara Falls. To see the task of making the huge raceway actually in hand was enough to stimulate the enthusiasm of any electrical engineer, and there were not a few members of the party glad to note that there was every possibility of developing a new industrial city near the Falls without in any way spoiling the wondrous natural beauty of the scene. Perhaps there were not a few, also, who were struck with the possibilities of local utilization of all the power derivable, and with the idea that it might be better to have a new Buffalo near the Falls than to try to take part of the Falls to old Buffalo.

It has, in fact, seemed to us that a good deal of the talk about delivering cheap power in Buffalo is rather wild, and likely to do more harm than good to many long-distance projects that have in them larger elements of reality and necessity. We are presented with figures showing that the Niagara Falls Power Co. will deliver power on the spot, at the cataract, at a rate ranging from $10 per h. p. for 5,000 h. p. up to $21 per h. p. for 300 h. p. These figures, however, take no account of current generation, transmission and transformation, all of which have to be added, and for which precedent furnishes very little precise information. But let us for a moment take a few figures on the other extreme of water-power service, and see what it can sometimes cost.

In the reports of the water-power of the United States of the Tenth Census, we find the case of Lawrence, Mass., which was taken up, and the value of which was discussed in a paper read recently by C. T. Main, before the American Society of Mechanical Engineers. Basing his figures on the census report, Mr. Main calculates that the total cost per horse power of developed plant there is $130, which includes an item of $20, due to making the plant large enough to compensate for the fluctuation due to the rise and fall of the river. Deducting this amount, therefore, in order to cover a case where the water supply is uniform, we have $110 as the cost per horse power for a fall such as we find at Lawrence.

Now, a good steam plant in 500 h. p. units can be installed for $65 per horse power, so that the ratio in favor of steam there is about two to three. The operating expenses for both cases is given by Mr. Main at $13.70 in the case of water and $21.80 in the case of steam per horse power per annum. But to the figure given for water must be added the cost of steam, or equivalent plant, for heating the buildings in winter, which is taken as equal to one-fifth of that required for steam power, and the expense of maintaining it. This item, when added, brings the cost of the maintenance of the water plant up to $19.13 per horse power per annum; that is, slightly under that of steam; but, as will be noted, with a far greater original outlay.

In the case of Lawrence, Mass., cited above, objection might be made that the cost of power given was too high. While it is true that in some cases the cost of water power in this country is lower than given, yet, on the other hand, not a few cases can be cited in which it is considerably higher, reaching in some cases as high as $25, so that we believe the case cited is a good one for the argument we are making, and that the figure will hold.

At the Buffalo Convention, some data from the Oerlikon Works was cited to show how inexpensive the electrical part of the work would be. For instance, "the cheapest kind of a line" would suffice to carry 25,000 volts for 22 miles! We beg to differ most emphatically. A summer holiday trial in a quiet region of Germany is no test of the average conditions obtaining for six months of the year, along the storm-swept, exposed southeastern shore of Lake Erie. So far from the "cheapest kind of a line" sufficing, Prof. Elihu Thomson seems to have his doubts of everything short of a first-class oil pipe line with special methods of insulation between pipes and conductor. Moreover, the figure is given of only $36 per horse power for the generating and transforming plant. If it is secured for twice that, even on large units, the promoters will be doing pretty well. The cost of the Frankfort-Lauffen plant was about $285 per effective horse power, in the ratio, it is stated, of $46 to $49 per horse power for the apparatus and $236 per horse power for the line.

It is said, and with truth, that these figures are high. But there needs an enormous cutting down in investment and maintenance before this power can be delivered and distributed in Buffalo to compete with the steam now manufactured there at about $35 per horse power. We are personally very much inclined to believe with Mr. William

Stanley, Jr.—no mean authority on this subject—that most, if not all, of the power will be used around Niagara Falls. It will certainly be cheap at that point, and its utilization there with the aid of electricity will still be one of the great engineering feats of the century. People talk gabble about using the power of Niagara in New York City. It is vastly more within the bounds of likelihood that we shall have to drink the water of Lake Erie instead of running our factories with it.

HIGH AND LOW SPEED ENGINES IN ELECTRIC RAILWAY WORK.

Our readers who have been following the discussions appearing in our columns on the best type and size of engine to be employed in central stations will find much food for thought in the results of a test carried out at the power station of the East Cleveland Railroad Co. by Mr. Chas. W. Wason. The tests are of all the more value for the purposes of comparison, as both the high and low speed engines are of the single cylinder type, working non-condensing and representing standard types of construction. In view of the diversity of opinion which still exists as to the merits of the two types tested, it must be considered as remarkable that the consumption of coal and water was so nearly identical in both cases, with, however, a very slight difference apparently in favor of the low speed engine. In drawing conclusions from these tests it would be well, however, to bear in mind that electric railway work is of such a variable character that the highest economy with either type of engine is not attainable, so that it would be unwise to generalize from these tests as to the economy of engines of either type employed in electrical work of a more uniform character. While these tests are of unquestioned value, the record requires to be still further amplified by a test of low speed direct-connected engines and of condensing engines of both types. We believe that American electric railway power stations embody examples of every one of these types, and some concerted action for the purpose of carrying out tests appears to be not only possible but timely.

MUNICIPAL LIGHTING PLANTS.

Discussion of the question of municipal ownership and operation of street lighting plants has recently assumed some prominence again in the daily press and otherwise. One of the most absurd contributions to the discussion that has come to our notice is to be found in a paper by Michael A. Mikkelsen, Johns Hopkins University, printed and circulated by the American Academy of Political and Social Science, Philadelphia, under the title "Electric Street Lighting in Chicago." It is absurd as failing to notice items of cost that should be patent to any person assuming to write upon an economic subject. Because the annual cost per arc light, in the Chicago municipal system, is stated to be $68, while Boston pays private corporations, according to Mr. Mikkelsen, $237.25, [the correct figure for Boston is $146, as given in report of Lamp Department,] he concludes that Chicago is effecting a large saving, and implies that municipal ownership is a manifest advantage. Mr. Mikkelsen omits to mention that interest, taxes and depreciation are not taken into account in the cost per light of the Chicago system. He gives the outlay "for organization and maintenance" to the date of his paper (which date nowhere appears) as $556,000. This we take to be cost of the plant.

Reported cost per year of service, 900 lamps @ $68.	$61,200
Add interest and taxes on $556,000, say 6 per cent.	33,360
Depreciation " " say 5 per cent......	27,800
	$122,360

Or $135.96 per lamp, more than double Mr. Mikkelsen's figures.

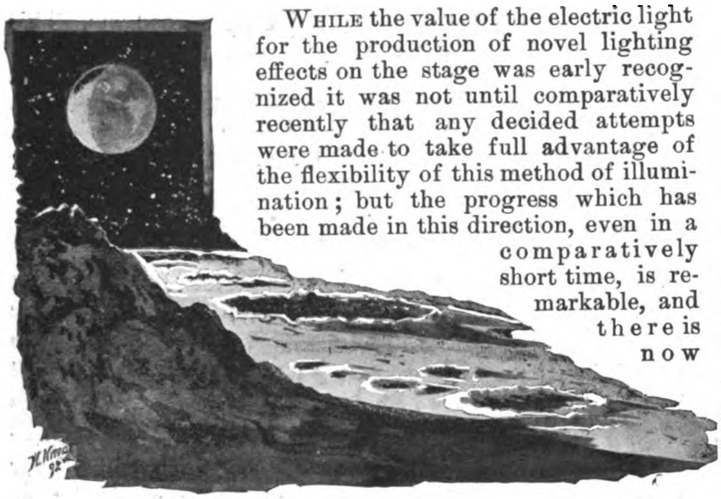
The above takes no note of water rates or of certain salaries, over and above the operating force, which we understand should be properly included. It has been stated that the actual cost to the city of Chicago, when all legitimate charges are included in the reckoning, is not less than $190 per lamp per year. It is somewhat suggestive in this regard that the Chicago Arc Light and Power Company has recently tendered for lighting a district of the city not yet equipped by the municipality at $182.50.

The question of public advantage as between municipal and private ownership of lighting plants is one that should be considered on a less partisan basis, and with less heat than hitherto, with more candor and a wider inclusiveness of the facts upon which it depends. *A priori* reasoning will not settle it. The objections to municipal ownership are obvious enough in view of the general conduct of public works, as to both cost and efficiency in our large cities. Its possible advantage can be shown only by the production of a complete service record, and an inclusive and unquestioned accounting of the operations of a considerable number of city plants.

POLYPHASE MOTORS IN AMERICA.

The claims which individuals and nations make for inventions of great merit are frequently apt to be obscured owing to a lack of proper understanding of the points at issue while often, in addition thereto, the records available are not drawn upon. We think this is exemplified in a marked degree by the controversy which has arisen as to the inventorship of the three-phase alternating motor as employed in the Lauffen-Frankfort experiments. Mr. Tesla early laid down the broad principle of the rotating field, employing currents of different phase, and described in his patents methods of operating at 90 and 60 degrees phase difference. The later substitution of one name for another to designate the same principle, evidently does not constitute invention, so that Mr. Tesla must be conceded to be the originator of the polyphase alternating motor system. But it is a matter of additional importance to know that such motors were first operated in this country and that, as described by Mr. Albert Schmid, on another page, a three-phase alternator has been in commercial operation for some time past. Mr. Schmid also shows that the work on this type of motors has steadily advanced, and that Tesla machines of no less than 1,000 h. p. are now commercially available. It is evident that we have at hand already in this country apparatus for the heaviest work in long-distance transmission that is likely to come up, not excluding the magnificent schemes for harnessing and distributing Niagara.

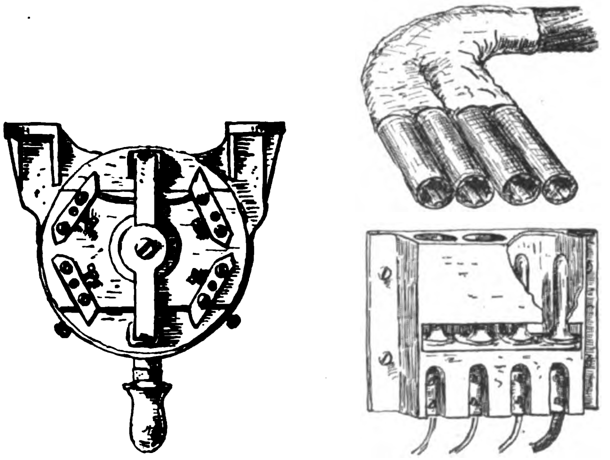
ELECTRIC LIGHTING ON THE "URANIA" THEATRE STAGE.



While the value of the electric light for the production of novel lighting effects on the stage was early recognized it was not until comparatively recently that any decided attempts were made to take full advantage of the flexibility of this method of illumination; but the progress which has been made in this direction, even in a comparatively short time, is remarkable, and there is now no character of stage lighting work, even the most complex, which cannot be effected electrically.

The perfection to which stage lighting has arrived is admirably exemplified in the methods employed in the production of the scientific performance entitled "A Trip to the Moon," which is now being produced at the Scientific Theatre "Urania" at the Carnegie Music Hall in this city —a performance we would strongly advise all our local readers to see. The apparatus and methods here employed were designed by Mr. J. C. Mayrhofer, electrical engineer, of New York, and consist of 850 incandescent lamps of 24 c. p., each operating at 110 volts and including a system of five arc lamps taking 12 amperes each, intended for sciopticon illumination.

One of the most important pieces of apparatus employed is the stage regulator, illustrated in Fig. 1, which was specially constructed for this purpose by Siemens & Halske, of Berlin, and which is arranged for eight circuits and for three changes of color in each circuit. The board is seven feet high and has a base three feet by two, and is so arranged that every possible shade of color can be obtained, together with every variation in strength of the light. The blue, red and white colors are produced by lamps having bulbs of corresponding color and are switched on independently, by means of the switches shown in the four vertical rows. The construction of these 24 switches is shown in Fig. 2. By turning the handle to the left the full current is turned on to the lamps, while turning to the right throws in the full resistance and practically extinguishes them. For every group of lights there is, in addition, a rheostat, which is placed in the base of the regulator as shown, and each group is controlled by one of the switches on the horizontal board. Each resistance is graduated into 68 steps, and the switches are so arranged that two groups, of different colors, can be regulated simultaneously.



Figs. 2, 3 and 4.

Mr. Mayrhofer has designed a special arrangement of the sciopticon illumination for reproducing the sun and moon and their eclipses, using the arc light for this purpose. The apparatus employed consists of a system of achromatic lenses, which in this instance, owing to lack of room, are placed three or four feet behind the transparency forming the background of the scene and which throw the light upon the transparency in an intense beam of exceedingly sharp outline. In the representation of the eclipses of the sun and the moon a number of sciopticons are employed simultaneously, the beam of light from one sciopticon completely covering that of the other.

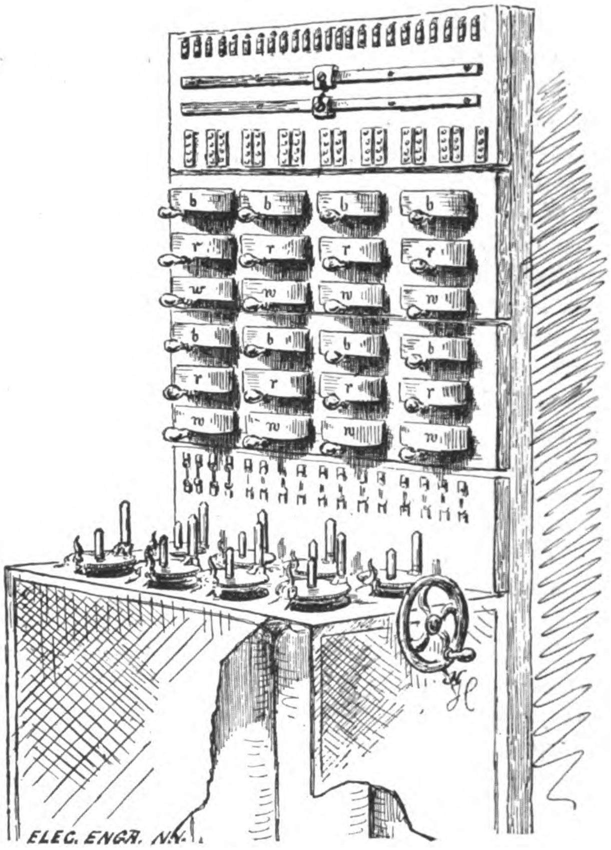


Fig. 1.—Stage Regulator.

The reflection of the heavenly bodies on the surface of water, and the imitation of waves is also produced by the projecting apparatus, by means of three glass plates having a wave-like picture upon them and which are progressively rotated in front of the lenses by means of a clockwork and an eccentric lever. This arrangement is entirely new and exceedingly effective.

Among the other novel forms of apparatus which are brought into play in the scientific theatre are a rail and slide apparatus, as well as the portable cable connection and stage pockets. The former are so constructed that all the ecliptic and parabolic curves which the heavenly bodies traverse or describe in their orbits can be reproduced, a problem which evidently required the highest skill in the application of stage mechanism. The portable connection apparatus is illustrated in Figs. 3 and 4. The connection between the stage regulator and the stage pockets is permanent each having four circuits and the groups of lamps are connected to these stage pockets by four-conductor cables with socket terminals, as shown in Fig. 4. This connection is a very simple one and is specially adapted for traveling theatrical companies.

In order to reduce the number of lamps required Mr. Mayrhofer employs colored lamps of large candle power, so that a smaller number of lamps suffices to give the desired illumination. This is a departure from the methods heretofore employed but the results have shown it to be an eminently wise one.

THE GAS BATTERY AS AN ACCUMULATOR.

BY

W. M. Stine

THE article in a recent number of THE ELECTRICAL ENGINEER on "A Combined Accumulator and Gas Battery," by Mr. F. A. La Roche, recalls to the writer some results obtained during a somewhat similar series of investigations pursued a year ago. Though differing in details they appear to have a direct bearing on the experiments above referred to.

At that time my experiments were simply preliminary to a series I am still at work upon. Though the data obtained are still incomplete, they possess so much interest for me that I am anxious to see the matter thoroughly worked out. Pressing routine duties leave no time for the present for their further prosecution, and I give my results in the hope that they may be of some value to other workers in this field and may perhaps contain some suggestions for them. I present them as an abstract from a paper on "Some Forms of Carbon Storage Batteries," which was read before the Physical Section of the American Association for the Advancement of Science at the Washington meeting last August.

The ideal in designing accumulators is to obtain maximum output with minimum weight. It is preferable to have this energy delivered at a reasonably high voltage per cell, with intensity, rather than simply quantity of chemical action; necessitating fewer cells for a given purpose. This ideal storage is doubtless that which would result from the decomposition of water on charging, with the subsequent reunion of the H and O on discharge. In the formation of water from the constituent gases more energy is liberated than in any other practical chemical reaction. Such a battery would develop a high voltage and store the most energy for a given current, while the mass of matter involved in the chemical reaction would be the least possible for an ampere of current. All this is clearly demonstrated in the gas batteries of Grove and others. It is, however, acknowledged to be impossible to reduce this ideal battery to a practical working form, for the reason that gases act in such cases only in solution.

In a series of investigations made by the writer it became necessary to employ a modification of this type of battery, and a modified form of the carbon electrode was used. The high absorptive power of finely-divided carbon for gases was utilized. Well-burned animal charcoal was treated with acid to dissolve out the mineral matter, and then thoroughly washed and dried at a high temperature to expel all gases absorbed by it. This dried mass was moistened with a 40 per cent. (by weight) solution of sulphuric acid and packed in small battery tumblers around the porous cups which were also filled with the same mixture. Plain arc carbons were heated and inserted for the electrodes, and so connected as to make the carbon in the porous cup positive. A current of one ampere was generally employed in charging and the potential carefully noted by a voltmeter.

A noticeable feature of these cells was the rapidity with which they acted with a very small charge. The first charge was continued for five minutes and they behaved quietly and without gasing, except at the water-line if made too moist. Such charges usually developed voltages ranging from .9 to 1.4 volt. They were then discharged through an electric bell, to determine relative efficiency. As an audible voltmeter, a bell possesses some merit.

The first five-minute charge given to a cell would usually ring the bell for nine minutes, and this increased by use to from 15 to 25 minutes. Increasing the time of charge showed that the cell reached its limit of economical capacity in about ten minutes, when the voltage became 1.7 to 1.9. When pushed beyond this the cells would gas badly, though the voltage increased slowly and in some cases reached 2.79 volts.

The stability of the charge was, however, low. While standing charged for an hour the voltage decreased considerably, and the decrease was more marked during the first hour following the charge than subsequently. But the output in watts was but slightly lower than when discharged at once. This greater immediate activity of the cells is doubtless due, to a great extent, to the amount of gas still remaining in solution; and the decrease upon standing must have been caused by the progressive absorption of the gases by the carbon, thus taking them out of solution and thereby increasing the internal resistance.

The cells were frequently allowed to remain charged for 12 hours and occasionally the charge had almost entirely disappeared by the end of this period. This was accounted for, in part, by the appearance of the oxygen, or positive electrode, when withdrawn from the cell; it was invariably eaten and furrowed. In one case where the cell had been in use for some time, the electrode was found reduced to the thickness of a lead pencil. It resembled the worn zinc from a Leclanché cell, and the carbon appeared to have been consumed rather than simply disintegrated. The hydrogen or negative electrode in no case showed signs of corrosion, except where, by change of polarity, it had been positive. This oxidation of the carbon finally led to an abandonment of the experiments.

Though convinced that a gas battery, pure and simple, is not practicable, yet the idea of combining it with an accumulator is an excellent one, and should be successful. If, instead of combining the gas battery and the accumulator in a single cell, the gases were led through pipes into another cell, where they would be kept separated by such a device as Mr. La Roche used, this gas cell could be connected in parallel with the accumulator and the energy lost by gasing almost completely restored. Were the gas cell to contain some absorbent substance in connection with a liquid, it would appear to yield better results. It is possible that the oxidation of carbon and the increasing internal resistance which occurred during my experiments would not take place under the high pressures here employed.

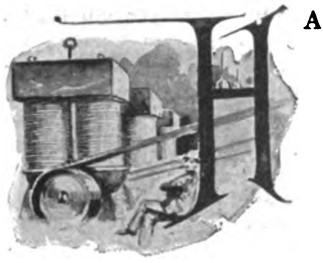
While charging, this gas cell could be thrown out of circuit and then, when connected in parallel, the two cells would form branches of a divided circuit, each containing its own E. M. F. It is evident that dynamic equilibrium would be maintained even to complete discharge. There would be some loss due to heating owing to difference of E. M. F. between the branches.

OHIO UNIVERSITY, ATHENS, OHIO.

THE MAGNETIC PROPERTIES OF OXYGEN.

COMMENTING on Prof. Dewar's recent experimental verification of the magnetic properties possessed by liquid oxygen, M. Guillaume points out in *L'Industrie Electrique* that if we accept the values found by Edmond Becquerel for the magnetic constant of oxygen, it ought, when in the liquid state, and in a field of medium strength, to possess a magnetic moment per cubic centimetre, one-third of that of iron, and a magnetic moment per gramme twice as great as that of iron; so that the strange conclusion is forced upon us that oxygen is the most magnetic of substances.

THE ELECTRIC PLANT AT THE VIRGINIUS MINES, OURAY, COL.



HARDLY a more striking example of the manner in which water-power developed at the foot of a mountain can be utilized at its lofty summit can be found than in the large plant which has been installed by the Edison General Electric Co. at the Virginius group of mines near Ouray, Colorado. It is one of the largest purely mining plants, if not the largest, in the world. Every difficulty likely to be met with in work of this nature was encountered in the installation. The pipe line is laid along the side of a rocky cañon; the wires from the power house to the mine are strung partly through dense timber, where they are exposed to damage from falling trees and partly above timber line, over rocks and snow banks, where the poles and wires are liable to be carried away by snow-slides and where lightning storms are frequent and violent. The line is nearly four miles long, the voltage of the current 800 volts, and the mine is wet. The relative advantages of the ground return and complete metallic circuit are illustrated, and switches are so arranged that either may be employed, the metallic circuit being used at present. The plant includes a variety of machinery, comprising two pumps, one hoist, one blower, and two motors running mills, indeed, almost everything except locomotives and drills, and these will probably be added shortly. Lastly the enormous saving that can be effected in many places by the utilization and transmission of water-power by means of electricity is strikingly manifested. Coal at the mines costs $18 per ton, and before the installation of this plant was made, the cost of the power amounted to nearly $40,000 per annum. This sum is largely saved by the adoption of electric power. An instance is also afforded of unprofitable mines being rendered profitable by the use of cheaper power, for while some of the mines in this group are rich enough in metal to repay working under the most

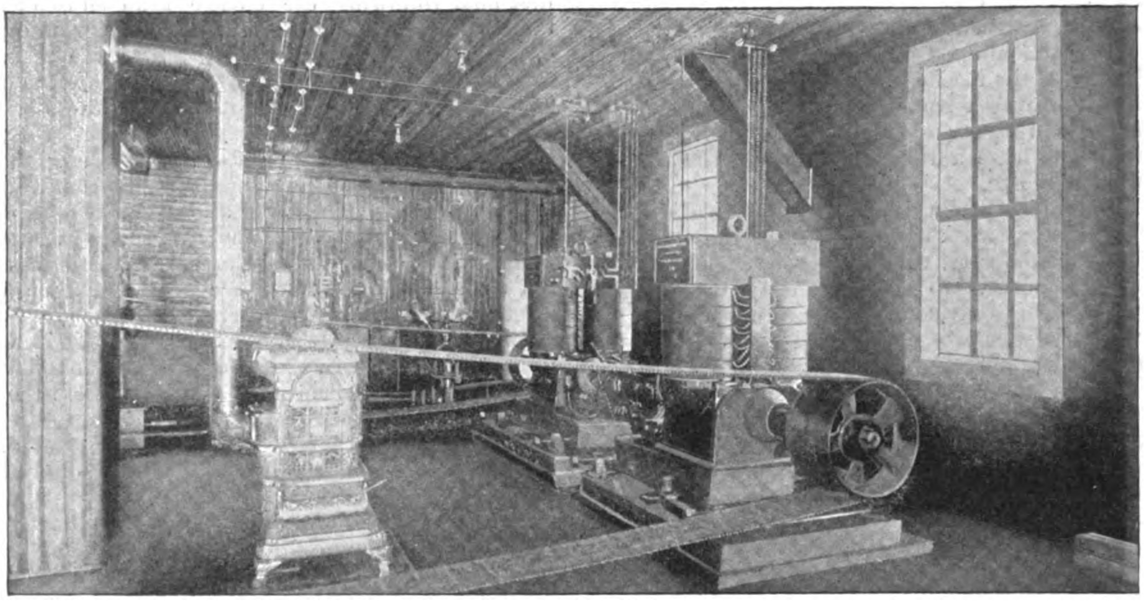


FIG. 1.—INTERIOR OF VIRGINIUS MINES POWER HOUSE, NEAR OURAY, COL.

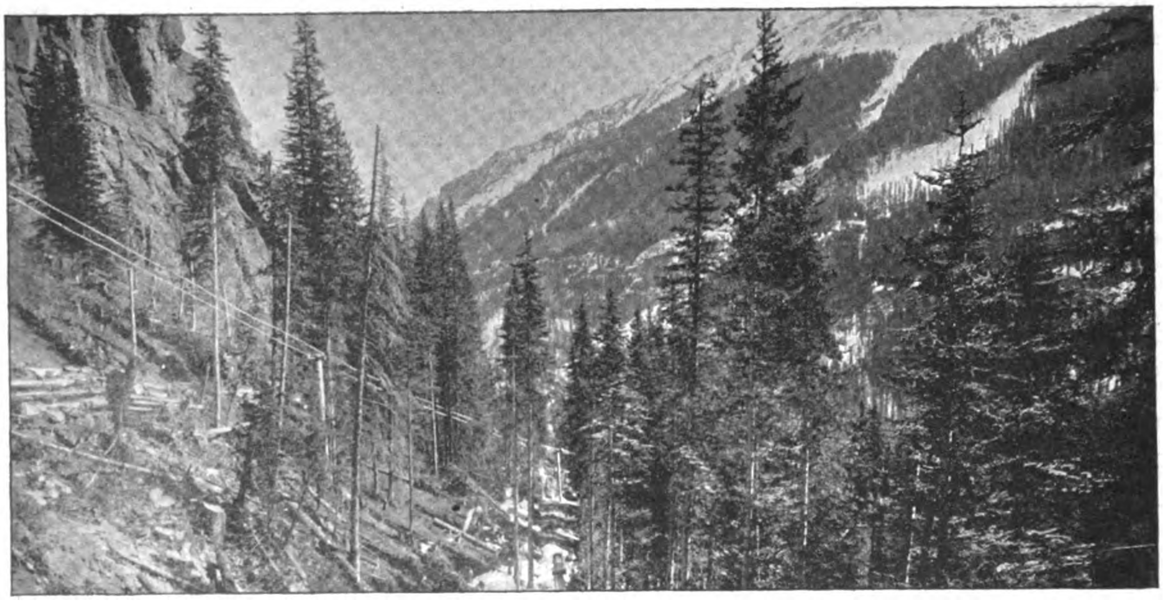


FIG. 3.—VIRGINIUS PLANT, LINE THROUGH TIMBER: ALTITUDE 9,000 TO 10,000 FEET.

adverse conditions, there are others of lower grade which would have been shut down in case the electric plant had proved a failure, but which, with the plant, will now yield a satisfactory profit.

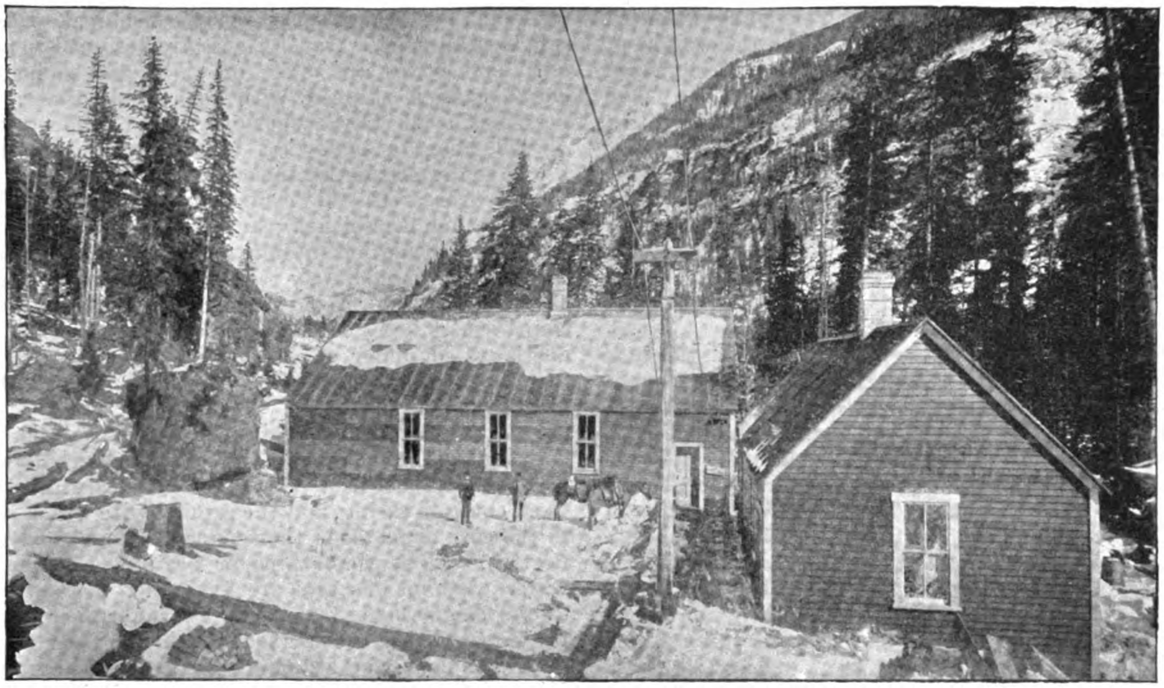


Fig. 2.—Power House; Electric Plant, Virginius Mines, Col., Altitude 9,000 Feet.

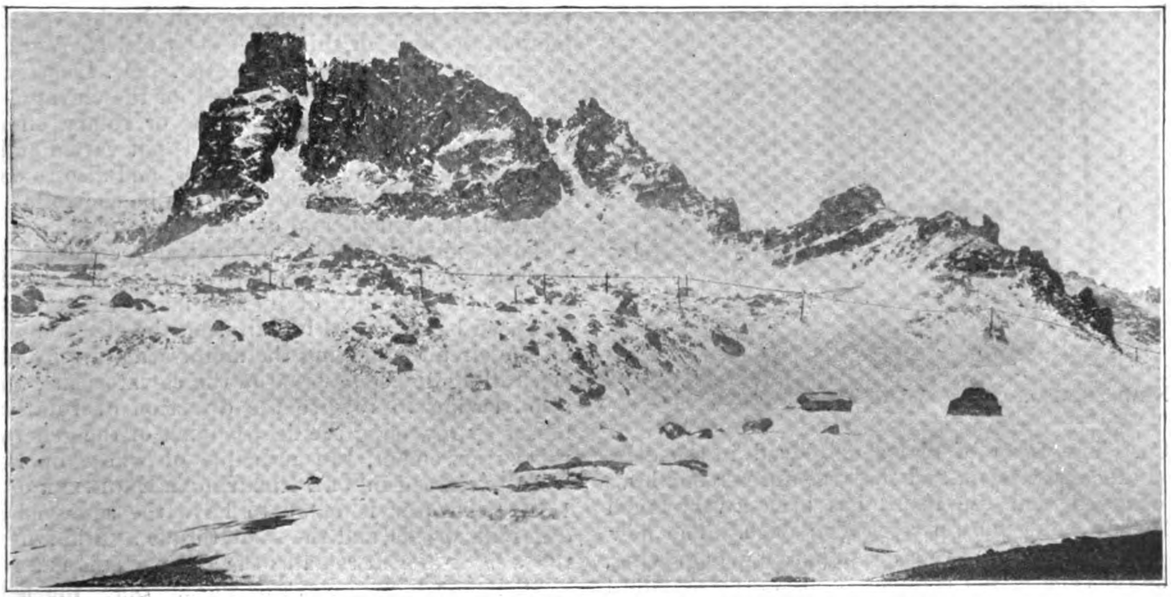


Fig. 4.—Line Across Snow Plateau: Altitude 12,500 Feet.

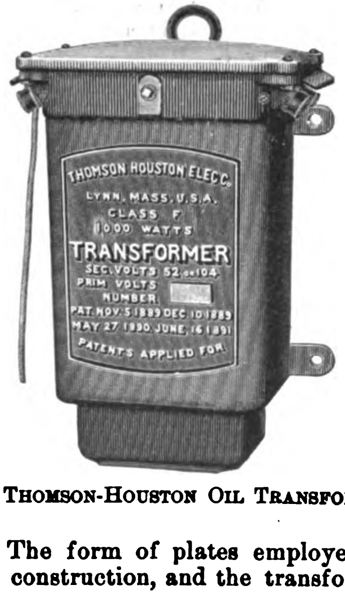
If a careful search of the Rocky Mountain region had been made with a view of selecting for the first extensive experimental mining plant, a location presenting every conceivable difficulty and which would prove a crucial test to electric power at the very outset, it is very probable that the Virginius Mine would have been chosen. The Virginius and neighboring mines, owned by the Caroline Mining Company, are situated near the summit of Mt. Sneffles, in the region of perpetual snow, at an almost inaccessible altitude of 12,700 feet above the sea and about 5,000 feet higher than the timber line. The water power utilized for the plant is in Red Cañon Creek, nearly four miles from the mines. The water-power plant consists of a small dam, and iron pipe line, extending along the side of the cañon, a distance of about 4,000 feet, giving an effective head of 485 feet, and two Pelton wheels, one 5 feet, the other 6 feet, in diameter, capable of developing under that head 500 h. p. and 720 h. p. respectively, or a total of 1,220 h. p., the two wheels being connected to separate shafts, so that either wheel may run the entire station. The electric generating plant comprises, at present, one 100 K. W. Edison dynamo and two 60 K. W. Edison dynamos, giving a total output of 295 e. h. p. The length of the line, as previously described, is a little over 19,000 feet. The electric machinery operated at the mines consists at present of two pumps, of 60 h. p. and 25 h. p., respectively, one hoist (25 h. p.), two Edison motors, each of 60 h. p. running concentrators and stamping mills and a 15 h. p. blower. The large pump which was erected when the plant was first installed, raises 150 gallons of water, 700 feet per minute, and is of the Knowles duplex type. An Edison standard motor is geared to it by a double worm, one right hand and one left hand, working into two spur-gears that mesh into each other and operate the pump, the object of the two worms being to neutralize the longitudinal thrust. The smaller pump, which was installed a few months ago, is somewhat similar, the motor, however, being mounted over the pump, with its armature vertical, the weight of the armature counteracting the thrust of the single worm employed. Both pumps have been working steadily and smoothly for several months, and have satisfactorily filled requirements.

The hoist consists of an Edison motor of standard type, but of street car winding and controlling switch, geared to the drum through the medium of a friction clutch. By means of the controlling switch and clutch, the hoist is under more perfect control than a steam hoist. The motors for the mills and blowers are of the standard type, and present no exceptional features.

The most serious troubles have been caused by lightning, electric storms in that section of the country being frequent and very violent. This has formed the subject-matter of particular study and special lightning arresters have been devised that give excellent protection. Since their adoption little or no trouble has been experienced from this source. That difficulties were encountered in the early operation of the plant is not surprising, and the fact that these difficulties have been overcome and the entire plant is operated successfully and satisfactorily under conditions that for severity are not likely to be exceeded anywhere, demonstrates the practicability of electric power for mining, and guarantees its success in this field.

THE NEW THOMSON-HOUSTON OIL TRANSFORMERS.

A radical departure in the manufacture of transformers has been recently taken by the Thomson-Houston Electric Co. The form of plates employed in the core, the method of construction, and the transformer box have all been changed, and the result has been a very much higher efficiency and a more perfect regulation. The new transformer, illustrated in the accompanying engraving, is known as the type F, and is manufactured in six standard sizes, ranging from 12 to 150 lights capacity.



New Thomson-Houston Oil Transformer.

One of the radical changes in the new type is the banishing of all fuses from the transformer box. For the primary circuits there has been designed a special combination of switch and fuse, which is in an iron box and which may be placed where convenient in the neighborhood of the transformer which it protects. By avoiding fuses within the transformer it becomes possible to seal the boxes hermetically after they are once in position, something which of course cannot be done when it is necessary to open the transformer at intervals on account of a blown cut-out.

A perfect and permanent insulation of the primary coil from the secondary coil, and both from the core, is a matter which has been very seriously considered, with the result that all type F transformers are designed to operate in oil. The boxes are made oil tight, and sufficient oil in closed cans is shipped with each transformer. The oil possesses some advantages over the paraffine usually employed, being a somewhat better insulating medium and filling the interstices of the coils more closely.

By reason of the oil insulation, the liability to burn out is very much diminished ; and even in case of a puncturing of the insulation by lightning or by other severe strain, the break is immediately re-insulated and the destruction of the transformer avoided. In the manufacture of the transformers great care is taken in the insulation, and each one is tested under a pressure of 5,000 volts alternating (equivalent to about 9,000 volts direct) before the introduction of the fluid.

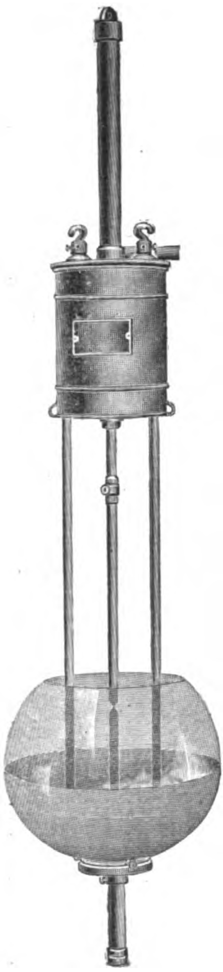
Another safeguard against loss of insulation between primary and secondary is added by the grounding of the core. The sheet-iron plates are very carefully insulated from the iron casing, and the ground wire which is attached to the core or plates is then connected to a good earth connection, such as water pipe or gas pipe. Where neither water pipe nor gas pipe are available, a good earth conductor can be made by placing a large copper or iron plate far enough below the surface to be in damp earth, imbedded in broken coke, and attaching the ground wire to the plate. With the core grounded in this way, a lightning discharge reaching it is conducted to the earth by the grounding wire, and the points at which the discharge took place are immediately re-insulated by the oil in the transformer.

LEONARD'S METHOD OF OPERATING ELECTRIC ELEVATORS.

The operation of elevators or the lifting of variable weights by means of electric motors involves problems met with in perhaps no other work to which electricity is applied, and hence our readers will be interested in the method devised for this purpose by Mr. H. Ward Leonard, of this city, and recently patented. Mr. Leonard's objects are mainly to enable the speed of the elevator-car to be varied without varying the torque or rotary effect of its armature so long as the weight is not varied and without varying the efficiency of the motor, and also to enable the speed and direction of movement to be controlled from the car itself in a simple and convenient manner.

To accomplish this he mechanically connects the operating motor with the elevator-car and connects the motor so that the strength of its field-magnet remains constant, its speed being varied by altering the electromotive force on the circuit supplying the motor-armature by means of a controlling device situated in the elevator-car ; this device also serving to reverse the direction of rotation of the motor by reversing the field magnet of the generator. By this arrangement, the principle of whose operation was fully explained in The Electrical Engineer of Nov. 25, 1891, the motor is made to have the same efficiency at different speeds and the same torque at different speeds if the weight moved remains the same. This is a feature of great importance in elevator work. Since the field is kept at a constant strength, no sparking occurs at the commutator-brushes, for the non-sparking point does not change materially. The reversal of the electromotive force is accomplished at a time when the same is at a minimum, and to reverse the motor the electromotive force of the supplying generator is first gradually reduced to a minimum point, then reversed, and then gradually raised to the point desired.

THE GRAVES LOW TENSION ARC LAMP.



Graves Lamp.

The Graves low tension arc lamp shown in the accompanying illustration, is the invention of Mr. W. D. Graves, of Cleveland, O., who has made the subject of arc lighting a special study for the last ten years, and has brought out many improvements in the arc lamp.

This illustration shows his very latest improvement and it not only embodies all the desirable features of his former lamp, but contains many that are peculiar to itself. This lamp does not contain any clock-work, dash-pots or complicated sets of springs, and the adjustment of the lamp is simple. The same winding answers for any desired quantity of current from four to twenty amperes, with very little adjustment of the mechanism. Thus it is obvious that a change in current or variation in potential affects the light far less than usual.

The carbons are held in suspension by mechanical means and thus a uniform length of arc is secured at all times, and the feeding is simply done by the shunt circuit. The clutch is very simple and will allow for greater variation in the size of the rod than is usually the case with corresponding freedom from wear. Should it become worn to such a degree that it does not work perfectly, it can be replaced by a new one very readily and at a very little cost.

The lamps are at the present time working with good results on 110, 220 and 500 volt circuits and also on $6\frac{1}{2}$, 8, $9\frac{6}{10}$, 10 and 18 ampere circuits. From this it will be seen that the lamp is adapted to any standard currents and can be used either on a multiple system, or in series, and in order to do this, it is not necessary to add any complicated mechanism to gain the desired results.

The designer of this lamp has arranged the construction to meet the convenience of both the trimmer and the repairer, making it possible for any ordinary workman to take it apart, clean, assemble and adjust it in the shortest possible time. All the screws and threads are standard, so that should any part become broken, it is not necessary to send to the factory for special screws or parts.

The lamp when constructed for constant current circuit is provided with two positive automatic cut-outs, and when the carbons are consumed, the lamp is cut out through no resistance, and thus saves the power required to run the lamp when burning and makes it practically impossible to burn out the coils or any other part of the lamp.

THE DEVELOPMENT OF ELECTRIC TANNING.

According to *La Lumière Electrique* several French tanners have adopted the electric tanning process, but have not made the fact public "for fear of displeasing a clientèle always distrustful of new methods." The Société Brion et Dupré is known to employ six drums, capable of an annual output of 600 tons of tanned hide. In Portugal there are two electric tanneries at work, at Porte and Braga, having an annual output of 700 tons of tanned hide; and in Madagascar an electric plant is being set up. In Brazil, at Boa Vista, some eight miles from Rio de Janeiro, there is an electric tannery covering about 13 acres, and possessing no less than 100 drums. The annual output of the Boa Vista plant will ultimately be about 70,000 tons.

STAGE LIGHTING BY ELECTRICITY.

BY

Dr. Graham Scott

Few theatre-goers realize the lavish expenditures on light which managers are obliged to make in order to present a realistic stage picture.

The calcium light is most commonly used for stage work, though attempts have been made to substitute cheaper illuminants, such as magnesium, zirconium, and carburetted hydrogen, or illuminating gas. None of these being adequate to the demands, however, attention has been turned to electricity, which promises to meet the requirements made upon it.

Developments have recently been made in this line by the Scott Electric Co., of New York. In some of the European theatres ordinary arc lamps of from six to ten amperes have been used, but in them the fault has been that the candle power obtained from so small a light is insufficient to admit of the screening or "toning" necessary to diffuse and overcome the violent glare of electric light. They have been, in most cases, obtained from street circuits of a potential too high to be safely handled. The Scott lamp is adapted to constant potential circuits of low voltages and is self-focussing. A current of from 12 to 20 amperes at a potential of 50 volts is usually supplied, giving from 2,000 to 5,000 c. p. against 900 to 1,200 c. p., the maximum of the calcium light.

There are many advantages to be gained by electric lighting. First, and perhaps the most important, is the instantaneous control which the operator obtains over any number of circuits however widely distributed, allowing the production of effects which with calcium would be impossible.

Second, a much stronger light can be produced and regulated than with calcium, and, with the aid of filterers to diffuse it, richer and more mellow effects can be obtained. By the use of a lens, greater accuracy is secured in focussing than is possible with a calcium light.

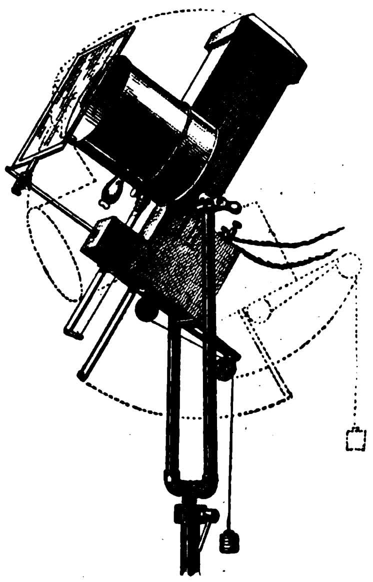


Fig. 1.—The Scott Lens Box for Electric Stage Lighting.

Lastly, yet of most importance, is the greatly reduced cost of electric lighting, for the actual results show that an improved quality of light can be furnished at one-fifth the cost of any other. In many of the prominent theatres of New York, Chicago, St. Louis, and other leading American cities this apparatus has been introduced with gratifying results.

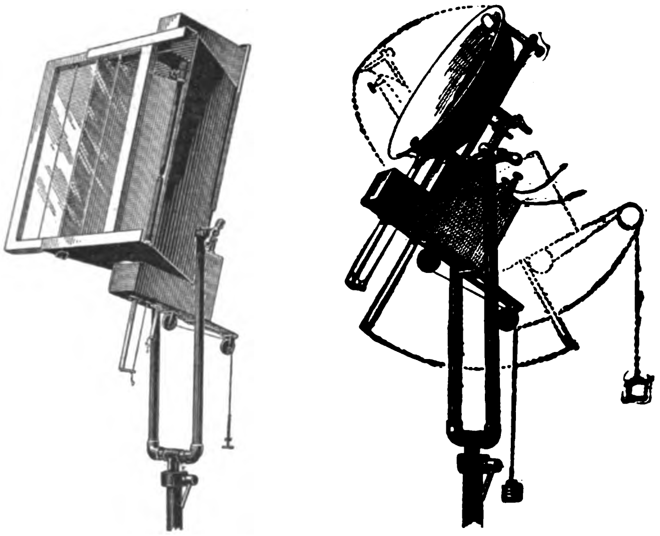
The accompanying illustrations show the electro-calcium lamp now in use. Its form is such that all the usual appliances, such as the lens box, Fig. 1, the color box, Fig. 2, or the reflector, Fig. 3, can be used as readily as with the calcium light. It will be noticed that the lamp can be placed at any angle, from below the horizontal to the vertical, and has a lateral range of motion that includes a complete circle. The electro-calcium apparatus is so compact and thoroughly mechanical in construction that many theatrical companies carry an outfit of from two to fifteen lamps, etc., on the road.

The flexible wires, pockets, switches and rheostats can be put up on stage and gallery in a few minutes, and if the electric current can be spared (as it can in most instances, each electro-calcium lamp taking the equivalent of only 30 16 c. p. incandescent lamps), it is but the work of a moment to couple the main connecting wire and series of necessary cut-outs and plugs with the electro-calcium outfit.

If the dynamo of the theatre is run to full capacity, it is always very easy to make arrangements with some outside electric company to run the necessary main wire to the theatre to operate the requisite number of electro-calciums.

The Edison Illuminating Co., of San Francisco, ran a wire in this way from their station to the Baldwin Theatre—about 2,500 feet—for Mr. David Henderson's "Crystal Slipper" company when performing there about a year ago. This company carried 15 of the Scott electro-calcium lamps on the road.

Mr. Henderson's "Sinbad" company is now carrying 18 of the electro-calciums on the road. The lighting of "Sinbad" is the most brilliant and gorgeous ever seen in the history of stage illumination. This gentleman is the first theatrical manager of the country to use the electro-calcium apparatus manufactured by the Scott Electrical Co., and with the able assistance of Mr. Martin Krueger, his electrician, has demonstrated to the theatrical world the uses and possibilities of electricity for stage lighting.



FIGS. 2 AND 3.—COLOR BOX AND REFLECTOR.

"Sinbad," with all the magnificent electro-calcium lighting effects, will be presented at the Garden Theatre, in this city, during the coming summer season.

Stuart Robson carries two electro-calciums on the road, and his manager, Mr. John Wooderson, and himself express themselves as perfectly satisfied with the apparatus.

Messrs. Richardson and Colby, managers for Francis Wilson, state that the company will save several thousand dollars during the season of 40 weeks by using the eight electro-calciums instead of the old style lime lights, for which they paid between $5,000 and $6,000 per season.

A COMPARATIVE TEST OF HIGH AND LOW SPEED ENGINES IN RAILWAY WORK.[1]

BY CHAS. W. WASON.

HAVING high speed and Corliss engines in our power house, I thought it of sufficient interest to make some comparative tests relative to the economy of the two types of engines. A brief description of our plant may not be out of place. Three Armington & Sims engines 14½ x 15 inches and three others 18½ x 18 inches of the same make, compose the high speed portion of our power plant. To each small engine are belted two Edison generators of 40,000 watts capacity and to each large engine are belted two 80,000 watt generators, manufactured by the same company. In the other part are two 28 x 48 inch simple Corliss engines made by the C. & G. Cooper Co., belted to countershaft, 7 inches in diameter and about 80 feet long with four clutch pulleys 88 inches in diameter by 28 inches in face made by the Hill Clutch Company, and from the countershaft are belted four 175,000 watt Edison generators. Our steam plant consists of 14 tubular boilers, 18 feet long, 72 inches in diameter with 72 4-inch tubes with Murphy settings. We have been able to use the same boilers in each test selecting those that would equalize the distance the steam was carried in each test.

Laboring under the disadvantage of not having an ampere meter of sufficient capacity to carry the entire current, we were obliged to station a man to read the individual amperemeters of each machine, they taking the amperes upon the sounding of a gong every 15 seconds. The water used for steam passing through a meter, it was an easy matter to determine the quality used during the 10 hours. Each wheelbarrow of coal thrown on the floor was weighed, so that we know the number of tons burned. An accurate account of the number of motor and tow cars moved and mileage made by each was kept. Hourly readings of the thermometer, and condition of the weather were noted. We used a Bristol automatic steam registering gauge. The temperature of the water as it left the Berryman heaters was taken every 15 minutes, also as it ran from the street main.

By taking readings of the quantity and pressure of current every 15 seconds, or in other words 2,400 readings in 10 hours, a very fair average of the electrical output has been obtained. Owing to the constant and rapidly varying load it is almost impossible to get the mechanical horse power. In taking a card with the indicator the load will change before the stroke is completed. I would very much like to hear from any one who has a device that will accomplish this purpose. I expected to find a greater difference in favor of the low speed over the high speed; of course, we have the countershaft to run in the former which load does not come in on the latter, giving in turn a factor of flexibility that is of much importance.

The following is the data of tests taken Feb. 14th, with high speed, and Feb. 21st, with slow speed plant:

1892.	Feb. 14th. high-speed engines.	Feb. 21st. Slow-speed engines.
Average elec. horse power developed in 10 hours	563	630
Maximum elec. horse power developed in 10 hours.	813	842
Minimum elec. horse power developed in 10 hours	486	354
Number gallons oil used in 10 hours	7 gal.	8 gal.
Water consumption for 10 hours	3,900 cu. ft.	3,800 cu. ft.
Water consump. per aver. elec. horse-power per hour.	43.29	37.69
Water evaporated per lb. coal per hour	6.61 lbs.	6.51 lbs.
Amount of bituminous slack coal used in 10 hours	36,900 lbs.	36,300 lbs.
Amount of ashes made in 10 hours	4,890 lbs.	4,779 lbs.
Amount of fuel used per aver. elec. h. p. per hour	6.55 lbs.	5.76 lbs.
Pounds of comb. used per aver. elec. h. p. per hour	5.68 lbs.	5.00 lbs.
Number of pounds of coal per car mile	6.57 lbs.	6.38 lbs.
Average amperes per 10 hours	812	907
Maximum amperes per 10 hours	1,120	1,160
Minimum amperes per 10 hours	720	720
Average voltage per 10 hours	518	518
Maximum voltage per 10 hours	535	530
Minimum voltage per 10 hours	505	510
Number of readings of 15 seconds intervals	2,385	2,395
Average temperature of water from heaters	186° F.	197° F.
Average temperature of water from street main	39° F.	39° F.
Average temperature of the outside atmosphere	43° F.	41° F.
Condition of weather	rainy.	foggy.
Average steam pressure as per automatic steam registering diagram	96 lbs.	97 lbs.
Maximum steam pressure as per registering diagram.	102 lbs.	100 lbs.
Minimum steam pressure as per registering diagram.	90 lbs.	90 lbs.
Average chimney draught	⅞ lbs.	15/16 lbs.
Number motor cars run on line[1]	62	62
Number tow cars run on line	9	10
Number miles made by motor cars	4,640.02	4,627.29
Number miles made by tow cars	767.65	806.53
Number passengers carried on cars	12,366	15,463
Number miles made by Brooklyn motor cars	61.75	87.28
Number miles made by Brooklyn tow cars	30.87	43.64
Number miles by Broadway motor cars	117.10	117.10
Number of Brooklyn motor cars	4	4
Number of Brooklyn tow cars	2	2
Number of Broadway motor cars	5	5
Number of Broadway tow cars	None.	None.
Total number of motor car miles	4,818.87	4,831.77
Total number of tow car miles	798.52	850.17
Total number of motor cars	71	71
Total number of tow cars	11	12
Total number of motor and tow cars	82	83
Total number of car miles made from power developed	5,617.39	5,681.94
Average horse power per car	6.86 h. p.	7.59 h. p.

[1] Fifty-four of these are No. 6, and seven are No. 14 Edison, with one T.-H. S. R. G. of 15 h. p.

Undoubtedly more data could be obtained (and more comparisons made; however, the above may prove a starter for others who are working in this unexplored field.

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[1] A paper read before the Cleveland, Ohio, Electric Club, March 1, 1892.

ACCUMULATOR CARS IN PARIS.

WHAT is termed the first serious trial of accumulator cars in Paris is reported as about to be made by the Société des Tramways de Paris et du Department de la Seine. If the experiment is successful, other companies propose to adopt the system, whilst new lines for the construction of which concessions have been granted will probably be similarly equipped. The first line of the Paris Company on this method is to be in operation between Saint

Denis and the Madeleine, and the cars are to attain a speed of 7½ miles an hour normally in Paris, 10 miles outside the fortifications, and 22 miles an hour if necessary! The cars to be used may be characterized as locomotives, as they will only contain the storage batteries, the motors and the driving mechanism. This type of car is the patent of the firm of G. Averly, of Lyons, and each axle is fitted with a motor of 15 h. p. The motors are of the Gramme or Siemens type. The cells are of the Laurent-Cély-Sarcia make. One of the peculiar features of the cars is the arrangement of mechanism which permits of their being derailed and placed on the line again as may be desired. The cars, which will shortly be put into service, are provided with electric brakes, and the weight of one locomotive with two trailing cars is 12 tons.

ON THE LAW OF HYSTERESIS.—V.

BY CHARLES PROTEUS STEINMETZ.

Cast-Steel, Annealed and Hardened.—Of one kind of steel, two test pieces were cast, at the same casting, turned off to standard size and, by comparing them in the magnetometer, found to be exactly alike. Then the one piece was hardened, the other left annealed. Magnetometer tests gave the following magnetic cycles:

TABLE VII.

	Hardened.		*Annealed.*		
	I	II	III	I	II
Maximum M. M. F., in Ampereturns: F =	44.5	65.5	108.0	44.5	101.0
Maximum magnetization B =	8,500	11,400	13,500	14,100	16,600

Herefrom as coefficient of hysteresis, was found

$$\eta = \underbrace{.02494 \mid .02512 \mid .02490}_{} \mid \underbrace{.007997 \mid .007962}_{}$$

Average, $\eta = .024987 \sim .025$ $\eta = .007980 \sim .0080$

Hence, when *annealed*, the hysteretic loss is $H = .008\, B^{1.6}$; when *hardened* $H = .025\, B^{1.6}$; and calculated by means of these formulas, we derive

$$\underset{\text{calc.}}{H} = 48{,}400 \quad 77{,}500 \quad 101{,}500 \quad 34{,}730 \quad 45{,}100$$

and

$$\underset{\text{calc.}}{H} - \underset{\text{obs.}}{H} = +100 \quad -300 \quad +400 \quad -70 \quad +100$$

$$= \text{per cent. of } \underset{\text{calc.}}{H} \quad +.2 \quad -.4 \quad +.4 \quad -.2 \quad +.2$$

It is especially interesting to note that though the chemical constitution of both samples is exactly the same, their magnetic behavior is entirely different, so that the *magnetic* properties of iron seem to be determined much more by its *physical* than its *chemical* constitution.

Another sample of cast steel of low magnetic conductivity gave the results shown in Table VIII.

TABLE VIII.

	I	II	III	IV
Maximum M. M. F.: F =	37.0	52.0	75.0	95.0
Maximum magnetization: B =	6,380	7,640	8,950	10,000

Average, $\eta = .001195$, *i. e.*, $\sim .012$

Herefrom, $H = .012\, B^{1.6}$

$$\underset{\text{calc.}}{H} = \quad 14{,}620 \quad 19{,}520 \quad 25{,}140 \quad 30{,}020$$

$$\underset{\text{calc.}}{H} - \underset{\text{obs.}}{H} \quad +20 \quad -380 \quad +140 \quad +420$$

$$= \text{per cent. of } \underset{\text{calc.}}{H} \quad +.1 \quad -1.9 \quad +.6 \quad +1.4$$

Soft Machine Steel.—(Table IX.)

TABLE IX.

	I	II
Maximum M. M. F: F =	39.0	90.0
Maximum magnetization: B =	14,800	18,800

Average, $\eta = .00936$; hence

$$\underset{\text{calc.}}{H} = 44{,}000 \quad 64{,}600$$

$$\Delta = -400 \quad +600 \text{ i. e., } \pm 1.0 \text{ per cent.}$$

Cast Iron.—(Table X.)

TABLE X.

	I	II
Maximum M. M. F.: F =	50.0	95.0
Maximum magnetization: B =	6,800	10,300

Average, $\eta = .01616$; $\underset{\text{calc.}}{H} = \quad 23{,}000 \quad 42{,}800$

$$\underset{\text{calc.}}{H} - \underset{\text{obs.}}{H} = \quad -300 \quad +800$$

$$= \text{per cent.,} \quad -1.5 \quad +1.9$$

Magnetic Iron Ore.—In the following, Table XI. are given the magnetic characteristics of a piece of magnetic iron ore, apparently pure Fe_3O_4 of the dimensions, 1 in. × 1 in. × $2\frac{11}{16}$ in.

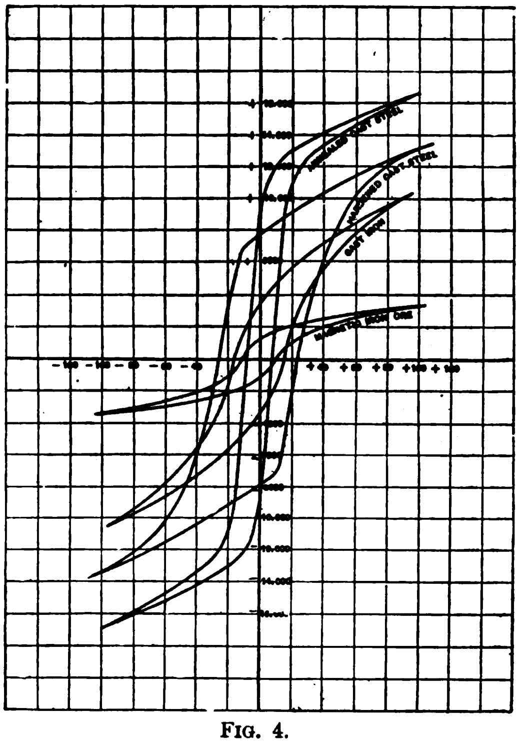


FIG. 4.

TABLE XI.

MAGNETIC CHARACTERISTIC.

F in ampere turns per centimetre length of magnetic circuit.
B in lines of magnetic force per square centimetre.

F	B	F	B	F	B
10	750	70	2930	140	3770
20	1510	80	3080	160	3930
30	2000	90	3220	180	4070
40	2320	100	3350	200	4200
50	2560	110	3470	220	4310
60	2760	120	3580	240	4400

TABLE XII.

CYCLIC MAGNETIZATION.

	I.		II.			III.	
F	B_r	B_d	B_r	B_d	F	B_r	B_d
0	± 900		±1020		130	3640	3740
10	0	+1520	− 200	+1660	140	3730	3820
20	+1200	1920	+1000	2020	150	3820	3900
30	1800	2230	1750	2280	160	3910	3980
40	2160	2500	2150	2520	170	3990	4050
50	2450	2700	2390	2710	180	4050	4110
60	2670	2850	2610	2880	190	4120	4170
70	2850	3000	2800	3020	200	4190	4230
80	3020	3120	2980	3150	210	4250	4280
90	3190	3250	3140	3280	220	4320	4340
100	3340	3360	3280	3410	230	4360	4370
110	3440		3410	3530	240	4400	
120	(106.)		3530	3640		(240.)	

$$\underset{\text{obs.}}{H} = 9{,}840 \text{ ergs}, \qquad 13{,}780 \text{ ergs};$$

$$\eta = .02049 \qquad .02041; \text{ Average}, \eta = .02045$$

Curve of hysteresis, $H = .02045\, B^{1.6}$

$$\underset{\text{calc.}}{H} = 9{,}820 \text{ ergs} \qquad 13{,}810 \text{ ergs}$$

$$\underset{\text{calc.}}{H} - \underset{\text{obs.}}{H} = -20 \text{ ergs} \qquad +30 \text{ ergs}$$

$$= -.2 \text{ per cent.} \qquad +.2 \text{ per cent.}$$

As seen, the coefficient of hysteresis of magnetic iron ore, $\eta = .020$, ranges between that of cast-iron, $\eta = .016$, and of hardened steel, $\eta = .025$. The magnetic conductivity is approximately 20 per cent. of that of wrought iron.

In Fig. 4 is given a comparison of the hysteretic curves of hardened steel, annealed steel, cast-iron, magnetic iron ore. This figure shows well the three characteristic forms of hysteretic curves:

TABLE XI A.

$$H = \eta B^{1.6} [+ \varepsilon N B^2]$$

H in ergs per cycle and cm.^{3}, B in lines of magnetic force per cm.^{2}, F in ampere turns per cm.

Material.	Hysteretic Coefficient. η	Magnetization at the M. M. F. $F = 40$	Residual magnetism R. For $F = 40$	Coercitive force C. For $F = 40$
Very soft iron wire (Ewing)...........	.0020	14700		(1.5)
Westinghouse converter, sheet-iron...	.0024	17800		(1.8)
Very thin sheet-iron, standard.......	.0030 [1]	17100		(2.3)
Thick sheet-iron.........................	.00333[2]	17500		(2.5)
Sheet-iron..................	.00421[3]	....		(3.2)
Sheet-iron..................	.00450[4]	....		(3.4)
Soft annealed cast-steel	.0080	14000	5100	6 0
Tool steel........	.0094	14800	8300	9.1
Cast-steel of low susceptibility	.0120	6400	2600	9.1
Cast-iron....................................	.0162	6100	2100	10.4
Hardened cast-steel......	.0250	8000	4500	19.0
Magnetic iron ore..........................	.02045	2320		

1 For $N = 100$. 2, $\varepsilon = .746 \times 10^{-6}$. 3, $\varepsilon = .2083 \times 10^{-6}$. 4, $\varepsilon = 1.16 \times 10^{-6}$.

(*To be continued.*)

Obituary.

AUGUSTUS CLASON GRAHAM.

WITH profound regret, we have to announce the death, under peculiarly afflictive circumstances, of the founder and first editor of this journal, Augustus Clason Graham, which took place early on the morning of Thursday, February 18th. After returning from a visit to the bereaved family of his brother, James Varnum Graham, who died in Flushing, L. I., on Wednesday, Mr. Graham was so prostrated with grief that he succumbed to a sudden attack of apoplexy, and passed away only a few hours later.

Mr. Graham was descended from an old and distinguished Colonial family, who traced their ancestry to the noted Scottish chieftain Græme, the historical hero of the Highlands. His father, John Lorimer Graham, was formerly postmaster of New York, and in his day a prominent citizen. Augustus Graham was born February 22, 1828, and received a good education in the best schools of the city. In 1849 he joined a party of fifty gold-seekers, who sought to reach California by ascending the Rio Grande. Before they had proceeded many days' journey, they were attacked by epidemic cholera in a malignant form, and in a few hours scarcely half a dozen remained alive. Mr. Graham took command of the remnant, and after unparalleled hardships, ultimately reached New Orleans, with two others, being the only survivors of the ill-fated expedition.

It is not too much to affirm that no more enterprising, public-spirited, generous and philanthropic citizen than Mr. Graham ever won the respect and esteem of the community in which his lot was cast. Of an eminently social disposition, and kind-hearted almost to a fault, he led the citizens in all good works, while the poor and needy found in him the best and most constant of friends. He always took a lively and abiding interest in all literary and educational matters, and for fifteen years prior to his decease had been the treasurer and most active member of the Board of Education of Whitestone, N. Y., his place of residence.

In January, 1881, in conjunction with Mr. C. B. Williams, he established *The Electrician*, of which he assumed the editorial and general management, the business department being in charge of Mr. Williams. This was the first essay which had been made in this country to establish a journal on broad lines, embracing the entire field of the electrical industries. The new journal took a high position from the start, and its cordial reception by those interested in the then rapidly growing electrical developments soon led the managers of other journals, which had already established themselves as exponents of the telegraphic, telephonic and other special interests, to enter the same field. Comprehending at once the new requirements of the situation, Mr. Graham associated with himself Mr. Franklin L. Pope, in the editorial conduct of his enterprise. The journal was at once enlarged and greatly improved in many ways; a broad, independent and vigorous editorial policy was marked out, which has been consistently adhered to from that day to this, and under its new title of *The Electrician and Electrical Engineer*, subsequently shortened to the THE ELECTRICAL ENGINEER, it entered at once upon an uninterrupted career of prosperity. Ultimately, seeking to withdraw from the cares of active business, Mr. Graham disposed of his interest to his associates, but it has been a gratification to them to feel that he has never ceased to manifest the warmest interest in the success and prosperity of the journal, to which his own intelligent conceptions and high ideals in earlier days contributed no unimportant share.

Mr. Graham leaves a widow and two children to mourn his untimely death.

EUGENE T. LYNCH, JR.

A GREAT many of our readers will be inexpressibly pained and grieved at the death in Memphis, Tenn., of Eugene T. Lynch, Jr., by a fall from his horse. From his active connection with the old United States Electric Lighting Co. in this city, young Mr. Lynch was well known to a very large circle in the electrical field. He served as an officer of both the National Electric Light Association and the New York Electric Club, and took a leading part in their affairs until recently, when he was tempted South by the large opportunities in electric railway work and the demand for electric lighting. As electrical engineer and contractor, he installed several plants, and was busy with a number of projects at the moment of his sad and untimely death.

Legal Notes.

LITIGATION IN THE FIELD OF INTERIOR WIRING.

THE growing importance and value of methods of interior wiring, combined with the spread of a well-founded conviction that before long nearly every interior wire for electric lighting will be run through tubes, has naturally led to litigation with regard to patents on interior conduiting, and there is promise already of a struggle for the possession and control of what must eventually be an enormously valuable field of work. The Interior Conduit and Insulation Company having announced its intention to maintain the claims it has made to a practical monopoly, both in fundamental principles and in detail devices, trouble has been taken to secure from it a statement as to the patents on which its case is based:

No. 176,784. Issued to Edward A. Hill, May 2, 1876.

Claims in combination a series of electric circuits, a series of inclosing tubes with occasional breaks giving access to wires from the surface of floors, walls, etc.

No. 343,087. Issued to L. Stieringer and J. H. Vail, June 1, 1886.

Claim in combination main and branch circuits in combination with distributing centres for interior electric lighting.

No. 401,498. Issued to Edward H. Johnson and E. T. Greenfield, April 16, 1890.

Claims the use of an insulating tube in a system of interior conduits in combination with the two wires of a circuit in one tube. Also a system of tubes consisting of mains, branches, etc., continuous from source of supply to points of consumption, except as intersected by switches, cut-outs, etc.

No. 469,208. Issued to E. T. Greenfield, Feb. 16, 1892.

Claims the same as above except that it covers the use of two tubes, each enclosing a single wire of a circuit.

Many minor details demanded in the practical working-out of a conduit system are also said to be fully covered by these and other patents, but the four patents above mentioned are considered ample to establish the company's contentions as to the following exclusive patent rights:

To employ a system of tubes for interior electric lighting.

To employ a system of electrical distribution in which a main circuit supplies a number of branches.

To employ a system of tubes in which the two wires of a circuit are placed in a single tube.

To employ a system of tubes in which there is a tube for each wire of a circuit.

With regard to the above we are informed that the Interior Conduit & Insulation Co. has secured an injunction against the Holtzer-Cabot Electric Co. under the patents mentioned above.

On the other hand, suit for injunction and accounting has been brought against Grace, Pinkham and Godfrey, who may be said to stand for the Interior Conduit Co., by the Indurated Fibre Industries Co., and the Builders' Insulating Tube Co. for infringement of what is known as the McMahon patent, covering the making of pipes, or paper tubing, to carry electric wires. The plaintiffs also announce their intention to bring suit against users. In the above suit, a demurrer has been filed on the part of the plaintiffs, which demurrer calls in question the validity of the McMahon patent. Argument is now awaited. The plaintiffs are making a paper tube called "Buildite."

A further aspect to the situation is given by the action of the New York Insulated Wire Co., the manufacturers of the "Vulca" composite duct. Their attitude in this triangular fight may be inferred from the following notice they have given out during the past week as to their claims:

First—We were the pioneers in advocating the system of single wires in conduits and demonstrating the "Duplex" or double conductors unreliable and dangerous.

Second—That the "Vulca" electrical wire ducts will stand the action of cements, plaster, acids, etc.

Third—We guarantee our customers absolute protection against all suits for infringements in using our Vulca wire ducts and complete system for interior wiring.

The above summarizes the situation, so far as any steps have been taken to enforce rights or determine them in this new and important field of work.

ANOTHER DOUBLE CARBON LAMP INJUNCTION.

JUDGE SHIPMAN of the United States Circuit Court, in this city, handed down, on March 1, his opinion in the suit of the Brush Electric Company against the United States Electric Lighting Company. The suit turned on the use of the "double carbon lamp." The Brush Company claimed the exclusive right to use this device under a patent granted Sept. 2, 1879.

Judge Shipman upholds this claim, and grants a perpetual injunction against the United States Company restraining that corporation from using the "double carbon" in the future. The defendant is also required to appear before United States Commissioner Shields to render an accounting of profits made on the use of the disputed patent in the past two years.

Patent Notes.

OPERATING CONVERTERS IN PARALLEL—THE STANLEY PATENT.

A PATENT relating to electrical distribution by alternating currents issued on March 1st, to the Westinghouse Company, as assignee of William Stanley, Jr., appears to have a very important bearing on the art as now practised in this country. The history of this patent is a somewhat remarkable one. In October, 1885, Mr. Westinghouse having previously secured an option to purchase the American rights of Gaulard and Gibbs for the original alternating system, which as then operated in London, had the converters arranged in series, like arc lamps, employed Mr. Stanley to make an experimental investigation of the system, with a view of adapting it to the requirements of the electric lighting service in this country. He took possession of an old disused factory in a secluded locality in Great Barrington, Mass., and commenced his labors. A descriptive paper written by him dated November 26, 1885, shows that he had at that early date become fully possessed of the idea that the converter must be so constructed that the counter E. M. F. opposing the impressed E. M. F. would vary in direct proportion to the variation in resistance and flow of current in the secondary circuit, and that to accomplish this it was necessary to use endless cores in the converters, and to connect them in multiple, all of which was a radical departure from the theories of Gaulard and Gibbs, but which has been abundantly proven to be the correct practice. By March, 1886, Stanley had completed a small plant and lighted up a number of buildings in Great Barrington at a considerable distance from the station, this demonstration being the earliest example of the practical use of the multiple arc self-regulating system of alternating distribution. About a year after this a small plant was erected by Marmaduke M. M. Slattery for the Sun Electric Company, of Woburn, Mass., which was in all essential particulars identical with that of Stanley. It had converters with endless cores placed in multiple arc, and was constructed with the same ratio of voltage, in primary and secondary circuits, and the same ratio of iron to copper in the converters, coincidences which were claimed in behalf of Stanley not to have been altogether accidental. The able and ingenious attorney who had charge of Mr. Slattery's interests, filed on April 5, 1888, an application for a patent, broadly covering in all its essential features a system of multiple-arc distribution so constructed and proportioned as automatically to maintain a correspondence between the number of lamps alight and the load on the dynamo. Immediately after the issue of this patent, No. 386,936, July 31, 1888, Mr. Stanley, by way of protecting the interests of the Westinghouse Company, filed an application covering exactly the same ground and making the same claims. A vigorously contested and protracted litigation ensued before the Patent Office lasting several years, which has been finally terminated by the decision of the Commissioner in favor of Stanley, resulting in the issue of his patent. Meantime, Slattery's interests had passed into the control of the Fort Wayne Company, and thence into that of the Thomson-Houston Company. The virtual effect of the Commissioner's decision and the issue of a patent to Stanley will be to render the Slattery patent void. As all multiple-arc alternating plants necessarily employ the construction and mode of operation covered by the Stanley patent, the indications are that the effect of the patent upon the relative strategic positions of the leading competitors now in the electric lighting field will be by no means an unimportant one.

Personal.

MR. FRANK SILLIMAN, one of the staff of the engineering department of the Thomson-Houston Electric Company, was one day last week presented with a handsome testimonial from the members of the same staff on the occasion of his marriage and departure to Savannah, Ga., where he has gone to accept an important appointment. The testimonial consisted of a dozen silver and pearl fruit knives, and a very handsome silver calendar, and was presented by Mr. W. J. Button, in a few appropriate words. The following gentlemen, members of the engineering staff, of the railway, lighting and international departments, were the donors: A. Jaastad, M. T. Kahurl, F. E. Greenwood, C. L. Howes, W. J. Button, H. W. Adams, G. D. Norton, J. F. Dubois, J. H. Watterman, A. Chandler, F. P. White and W. A. Chapman.

MR. ROBB MAC KIE, for the past two years electrical engineer of the Allied Electric Light Companies of Cincinnati, has resigned that position to establish an office as consulting engineer in that city. Mr. MacKie was formerly general superintendent of the Fort Wayne Electric Company and is widely and favorably known in the profession. He was elected a member of the National Electric Light Association at the recent Buffalo meeting. His long and varied experience in practical electrics fit him peculiarly for the occupation he has adopted.

DR. LOUIS BELL, who has been editor of *The Electrical World* for a little less than two years, has resigned, and will hereafter have no connection with that paper. It is understood that Mr. Carl Hering will do part of the editorial work in connection with his engagements as an expert in Philadelphia. Dr. Bell will devote himself to the important field of power transmission and railway development. His recent book, written in conjunction with Mr. O. T. Crosby, on "The Electric Railway," is a most valuable and useful publication.

College Notes.

PENNSYLVANIA STATE COLLEGE.

THROUGH the liberality of the Westinghouse Electric Co., a 500 light alternating incandescent dynamo, with constant current exciter, compensator, alternating voltmeter and ammeter, and a number of converters, have recently been added to the equipment of the electrical engineering department.

The trustees, on recommendation of Prof. Osmond, about a year ago, authorized the extension of the course to include a fifth year. Accordingly, the course for the degree of E. E. now requires five years; but at the end of the junior year, students who cannot remain two more years may take an approved course of one year (taken from the two) and receive the degree of B. S. in electrotechnics. This extension to five years makes it possible to bring into the course a large amount of mechanical engineering and also increase somewhat the distinctive electrical work both in the applications and in the advanced theory of electricity.

Students of the electrical department, especially Messrs. Bohn and Loyd, have recently designed and constructed a dynamo, on castings sent by Mr. Greenwood, of the Rockhill Furnace, for lighting the machine and car shops and other buildings of the furnace.

MOTORS ON THE U. S. S. "MIANTONOMOH."

INFORMATION comes to us that the Crocker-Wheeler Electric Company has just placed four of its perfected fan outfits in the turrets of the new U. S. S. "Miantonomoh," to blow the smoke away from the guns. This is surely a novel use of the electric fan.

Literature.

Magnetic Induction in Iron and other Metals. By J. A. Ewing, M. A., F. R. S. S., L. & E., M. I. C. E., D. Sc. London, *The Electrician Printing and Publishing Co.* 351 pp., 5 x 8 inches. price, $4.

For some time past the London *Electrician* has been publishing a series of excellent articles from the pen of Prof. J. A. Ewing, whose work in magnetism is generally recognized as classical. In these articles Prof. Ewing, without entering too deeply into the history of the subject, has placed before his readers an accurate record of the more recent and important work done in magnetism; and these articles, reprinted in book form, are now before us.

The work begins very properly with an explanation of the fundamental ideas embodied in magnetic work and measurement, a description of the methods of measurement usually employed for determining the value of iron and steel, and a number of valuable data exhibiting the results of measurements on various specimens of iron, steel, nickel and cobalt. The subject of magnetic hysteresis, a term which, by the way, was coined by Prof. Ewing, is naturally treated of with considerable fullness, and induction by very weak and very strong magnetic forces is described, together with the influence of temperature and stress.

Prof. Ewing then takes up the magnetic circuit with particular reference to the application of the theory to the construction of machines. The last chapter of the work is devoted to the molecular theories of magnetism, beginning with that of Poisson and Weber, Ampere and others, to which he has added his own most interesting theory recently developed.

The author, to use his own language, has, throughout, endeavored to familiarize the student with the notion of intensity of magnetization, (I) as well as with the notion of magnetic induction (**B**). "It has been urged by some writers," says Prof. Ewing, "that the alternative which is in this way offered is unnecessary and confusing, and that if we keep "**B**" we may dispense with "**I**." The scientific value and the practical utility of "**B**" are so obvious that no one proposes to avoid using that. It is "**I**" that we are told must go. In this cry the author is by no means disposed to join. It is not too much to say that in stating the magnetic qualities of a metal the quantity "**I**" is of primary importance. The facts of saturation, the molecular theory, and the phenomena of magneto-optics, all demonstrate its physical reality and its fundamental interest."

Like all of Prof. Ewing's works, this one is also enriched by copious reference to original publications and papers, so that the book as a whole presents the best résumé of this subject extant.

Practical Electrical Engineering. London, *Biggs & Co.* New York, *J. A. Penman.* Published in parts. Price, 75 cents per part.

This work which has been undertaken by some of the best electrical writers in England has already received a notice at our hands, and we have now before us Volume I, complete. This contains exhaustive chapters on electric measurements, steam engineering as applied to electric distribution, the construction of central stations, switchboards, etc., and the principal systems of underground electrical conduits employed in England, and to some extent in this country. There is also before us Part 12, consisting of the first chapters on secondary batteries, which contain excellent descriptions of the most modern types of cells, together with very clear illustrations.

Armature and Field Magnet Winding. By Edward Trevert, Lynn, Mass. *Bubier Publishing Co.:* 1892. 113 pp., 5 x 6½ inches. Illustrated. Price, 50 cents.

Although many works treat of the methods of design and the calculation of the windings for armatures and field magnets of dynamo-electric machinery, little has appeared on the practical methods of winding as carried out in the workshop. The author has in the present volume devoted particular attention to the latter subject, a variety of methods of winding drum and ring armatures being described from the workman's standpoint. In the short treatise on the method of calculating windings, the author has followed Kapp's method to good advantage.

Annuaire pour l'an 1892. Bureau des Longitudes, Paris. *Gauthiers-Villars & Fils.* Price, 1 franc 50 cent.

Besides the practical information contained in the *Annuaire* each year, the volume for 1892 includes a number of articles from the pens of well-known savants on monetary matters, statistics, geography, mineralogy, etc.

The Elements of Electric Lighting. By Philip Atkinson, A. M., Ph. D. Seventh edition, fully revised and enlarged. New York, *D. Van Nostrand & Co.* 260 pp. Price, $1.50.

This little work is so well known as to require no detailed review at this time, and it will therefore suffice it to say that it is brought down to date. It will give the layman and student an excellent idea of the modern methods and apparatus for generating, measuring, storing and distributing electricity.

The Ventilation of Buildings. By Alfred R. Woolff, M. E. Second edition. Pamphlet, 32 pp., 6 x 9 inches. Price, 25 cents.

Letters to the Editor.

LONG-DISTANCE TRANSMISSION AT ONE MILLION VOLTS.

In a communication to The Electrical Engineer of January 20th I sketched a system for the distribution of power by means of high-pressure continuous currents. I will now refer in more detail to the generating machinery, and to the line likely to prove most successful.

For some years it has been the practice in many central stations to operate arc generators in series, supplying lamps and motors; a further evidence has come to hand in the last few weeks of a system of this character at Genoa, which is on a considerable scale. I may therefore say at once that I have contemplated the operation simply of a large number of the ordinary constant-current generators complete with regulators running at any speed independently of one another in series. Nothing more nor less than this. Similarly for the motors, the constant-current machines with regulator operating on field for constant speed or constant voltage or ampereage of a driven machine.

Thury employs for his generators one field circuit which may or may not be a saving.

After experimenting with a static induction machine I have come to the conclusion, that up to 50,000 to 100,000 volts, overhead bare wires may be used, and consideration will show that at this pressure, the total energy of Niagara might be economically transmitted into the greater industrial centres of the North American continent.

As regards the line, above 100,000 volts, it may be liable to brush discharges, especially over a damp insulator. For high pressures therefore I would use oil insulated cables in which the brush or silent discharge is entirely suppressed and with which I believe pressures up to 2,000,000 or 3,000,000 volts can be readily carried.

It is a point for consideration as to whether petroleum or a viscous fluid is preferable. As in oil a movement of the fluid or apparent ebullition precedes discharge, it is probable that a difficultly movable fluid, as some qualities of Isolatine, would raise the pressure of discharge.

In the Brooks underground conduit, solid paraffine with oil in addition has been proposed. Of this, and any other oil insulated cables I should be glad to have particulars.

George Edensor Dorman.

Chicago, Ill., March 1st, 1892.

MOISTURE-PROOF CONSTRUCTION FOR IRON ROOFS.

With regard to Mr. J. Edwin Giles' communication on the iron roofs of the Edison Station at Hazelton, Pa., contained in your issue of Feb. 10, 1892, we feel certain that Mr. Giles could not have read our communication in regard to the subject of iron roofs published in your issue of Jan. 20, 1892, because there we described several methods in use by us, and two methods which give a thoroughly fireproof construction and not as expensive as the method he describes. We regret exceedingly that Mr. Giles did not call on us prior to the building of his station, as we feel sure we could have built him one which would have been more satisfactory than the one he now has. It seems foolish to have to put in an entire interior lining as he has done, which he himself says acts as a gutter to conduct the water which forms on the underside of the corrugated iron roof and running down to the sides of the building. We feel sure that with the fireproof sheathing we described in your issue of Jan. 20th no moisture will condense on the underside of the corrugated iron roof covering.

In regard to the covering describod by Dr. Amory, manager of the Brookline Gas Light Co., we would say we understand that this station has not been in use as yet, so we are not able to learn whether his experiment will be a successful one or not. Mr. Giles evidently failed to communicate with parties who had had experience in regard to the matter of iron roofs. Our company has made a special study of this for a great number of years, and we feel sure that we can give anybody satisfactory information should they favor us with communications on the subject.

Burr K. Field,
Berlin Iron Bridge Company. Vice-President.
East Berlin, Conn., Feb. 19, 1892.

CONDENSATION ON IRON ROOFS.

We have noticed an article in your issue of Feb. 10th by Mr. J. Edwin Giles, in regard to the condensation of moisture on the underside of iron roofs. We desire to state for his benefit, and that of others who have had trouble of a similar kind, that this problem can be solved in a satisfactory manner by the use of Mackite plaster boards as a lining for the corrugated iron, as we have practically demonstrated repeatedly in electric stations, machine shops, freight depots, etc. The construction with the plaster boards is very simple, as the fastenings holding the sheets of corrugated iron pass directly through the boards, securing them in place also.

We shipped several thousand square feet of Mackite to the Edison Electric Illuminating Co., of Easton, Pa., last September, to be used under the roof of their station, and we can refer to them. The advantage must be seen at a glance, this material affording a dry and fireproof lining for an iron roof, at a comparatively very low cost. We shall be pleased to correspond with any of your readers who are contemplating the erection of a roof of this description.

Eastern Plaster Board Company.

New York City.

WORLD'S ELECTRICAL CONGRESS.

It has been arranged by Mr. C. C. Bonney, President of the World's Congress Auxiliary, Mr. O. Chanute, Chairman of the Engineering Congress Committee, and Mr. Elisha Gray, Chairman of the Electrical Congress Committee, that the section of the Engineering Congress relating to Electrical Engineering shall be merged into the World's Electrical Congress.

Due notice of this agreement from the office of the World's Congress Auxiliary will follow the recently distributed circular relating to the Engineering Congress.

H. S. Carhart,
Secretary of the World's Electrical Congress Committee.

POSITION OF FEED-WATER HEATERS.

I have noticed by an inspection of various electric light and power plants throughout this country—that where condensing engines are used—in some cases a closed feed-water heater is placed *between* engine and condenser, and in other cases live steam is used to heat the feed-water or else the feed-water is not heated at all.

This seems an important point, and I should be glad to hear the expressions of opinions of various engineers of experience on the subject.

R. B. Owens.

University of Nebraska,
Lincoln, Neb., Feb. 20, 1892.

BUFFALO CONVENTION TRAIN SERVICE.

On behalf of the National Electric Light Association I desire to tender thanks through the electrical press to the following named gentlemen, for the very efficient service rendered and the numerous courtesis extended to our delegates during the recent Convention in Buffalo:

Mr. M. C. Roach, Gen. Eastern Pass. Agt., N. Y. C. & H. R. R. R., New York City; Mr. Edson J. Weeks, Gen. Agt. Pass. Dept., Buffalo, N. Y.; Mr. H. H. Parry, City Ticket Agt., Buffalo, N. Y.; Mr. J. C. Yager, Div. Supt. Wagner Palace Car Co., New York.

C. O. Baker, Jr.,
Master of Transportation.

National Electric Light Association,
New York March 1st, 1892.

Society and Club Notes.

GEORGE CUTTER ON INSULATION.

At the last meeting of the Brotherhood of Electrical Mechanics of Chicago, a large and attentive audience listened to a talk on "Conductivity and Insulation." Mr. Cutter's recent illness had prevented him from preparing a proposed series of experiments on this subject, but his lecture drew out quite a little discussion as to modern wires and insulations. After calling attention to the relation between the terms "conductivity" and "insulation," he showed how the conductivity of the wires in common use was brought to a high state long before the more thorough means of insulation were adopted. He then dwelt on the comparative value of various insulating materials, and called on the electrical mechanics to sustain the results produced by high-class material by taking good care of the joints and other trying spots.

A brief discussion on making joints and on means of testing insulation followed this off-hand talk, which incidentally paid a high tribute to the work and opportunities of the electrical mechanic.

THE PHILADELPHIA CENTURY CLUB.

At a recent meeting of the Century Electric Club, held Monday, February 8th, the following amendment was made to the by-laws:

"The membership of this organization shall consist of two classes, active and honorary. Active members shall be over eighteen years of age, and shall have been at least one year in practical electrical work. They shall also have a certain amount of theoretical knowledge, and their eligibility shall be thoroughly investigated by the membership committee."

Anybody desiring to become a member shall apply to Mr. Charles W. Carnes, Penn Mutual Building, Philadelphia, chairman of the membership committee.

FRANKLIN INSTITUTE.

At the meeting of the Electrical Section of the Franklin Institute, held January 5, Mr. H. S. Hering gave a description of some types of recording volt and ammeters, and suggested some new modifications. Mr. W. S. Aldrich continued his remarks upon electromagnetic machinery, with lantern illustrations. Prof. Houston read a paper on "An Early Conception of Magnetic Field," which was referred for publication.

At the meeting of the American Institute of Electrical Engineers, at 12 West 31st street, on March 15, Mr. A. Wurts will read an interesting paper on "Lightning Arresters."

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED FEBRUARY 23, 1892.

Alarms and Signals:—

Electrical Burglar-Alarm for Windows, F. C. Page, 469,266. Filed June 16, 1891.

Fire-Alarm System, H. Redding, 469,376. Filed May 15, 1891.

Has for its object to enable the circuit to be closed and the gongs briefly operated for the purpose of testing the system without giving the full alarm.

Electrical High and Low Water Alarm, A. C. McConnell, 469,424. Filed Dec. 2, 1890.

Conductors, Conduits and Insulators:—

Molding for Electric Wires, W. Gritten and A. Parmly, 469,241. Filed Apr. 27, 1891.

A molding for wires made of slag-wool.

Electric Conductor for Metallic Circuits, S. W. Holman, 469,248. Filed Oct. 10, 1891.

A metallic circuit conductor in which both wires of each circuit are arranged helically leaving an air-space in the centre of the cable.

Conduit for Cable or Electric Tramways, G. S. Morison, 469,262. Filed Dec. 29, 1890.

Claim 1 follows:

A railway conduit constructed in sections, the side pieces of each section overlapping each other at opposite ends of the section whereby when the sections are placed together, end to end, openings will be left alternately on opposite sides as pockets.

Tube for Electric Conductors, E. T. Greenfield, 469,469. Filed Mar. 21, 1891.

A conduit consisting of a small tube thrust into a larger tube which has been partly filled with a soft insulating material, which material is then allowed to harden or set.

Electric Cable, H. V. Hayes and J. S. Stone, 469,475. Filed Oct. 12, 1891.

A cable consisting of a number of associated pairs of compound conductors laid up in reversed layers and properly insulated.

Conduit for Electric Conductors, E. T. Greenfield, 469,470. Filed Aug. 14, 1891.

A junction sleeve or collar having a non-conducting ring imbedded in its inner surface.

Electric Cable, H. V. Hayes, 469,522. Filed Aug. 16, 1889.

A metallic circuit in which the direct and return wires are combined spirally with insulating material so that the thickness of the latter from the common axis of the spirals to the inner surfaces of the wires is greater than its thickness on the exterior surfaces.

Dynamos and Motors:—

Speed-Regulator for Dynamos or Motors, L. H. Leber, 469,257. Filed May 11, 1891.

A ball governor which operates by breaking the circuit completely when the machine attains too high a speed.

Electric Machine, M. von Dolivo-Dobrowolsky, 469,515. Filed Aug. 3, 1891.

A system in which the current-generating and the current-receiving devices, which are equal in number, are severally connected to form closed circuits, while the conducting or line wires are connected to equidistant points of the said circuits, or to the united terminals of the respective devices.

Dynamo-Electric Machine, J. Sohlman, 469,281. Filed Sept. 18, 1891.

Has two stationary annular armatures with induction coils, a central shaft carrying two groups of field-magnets and revolving within the two armatures; the pairs of armatures in groups having an equal number of poles, and the position of the corresponding elements of the pairs being relatively adjustable.

Electromagnetic Reciprocating Engine, M. J. Wightman, 469,441. Filed Feb. 5, 1891.

A reciprocating motor in which it is possible to alter the length of the stroke, the number of strokes per minute, and the relative strength of the force of the going and returning motion.

Galvanic and Thermo-Electric Batteries:—

Diaphragm for Electrical Cells, C. N. Waite, 469,428. Filed Feb. 18, 1891.

A dense, compact film of a metallic albuminate.

Lamps and Appurtenances:—

Electric Arc Lamp, W. D. Graves, 469,347. Filed Nov 9, 1891.

An automatic regulating device for arc lamps.

Electric Arc Lamp, F. R. Boardman, 469,362. Filed Jan. 27, 1891.

Consists of an insulated box containing a refractory block with two carbon holders rigidly connected to the box on opposite sides by insulated connections, a spring or weight within each holder feeding the carbons toward the block, a bayonet joint secured to one end of the carbon-holder, and a corresponding attachment upon the base of the lamp.

Incandescent Lamp, F. H. Manchester, 469,482. Filed Nov. 4, 1891.

An incandescent lamp base which shall be unaffected by change of temperature.

Incandescent Lamp, F. H. Manchester, 469,483. Filed Nov. 4, 1891.

Has for its object a lamp base which shall be more durable and less expensive than those in ordinary use.

Electric Lighting System, J. F. McElroy, 469,656. Filed June 4, 1891.

A car-lighting system in which the generator is operated by the motion of the train.

Miscellaneous :—

Electric Hose-Coupling, J. B. Strauss, 469,283. Filed Sept. 14, 1891.

An electric hose-coupling by means of which signals may be communicated through wires laid within the casing of the hose through any number of lengths, by means of which the firemen may communicate with the engineer.

Poison Cabinet, E. G. Kubler, 469,349. Filed Dec. 14, 1891.

Has for its object to prevent more than one bottle being removed from the cabinet at once, thus avoiding accidents due to misplacement of the bottles.

Automatic Electric Gas-Lighting Burner, R. C. Nourse and T. W. Lane, 469,408. Filed Dec. 29, 1890.

Electromagnetic Stop-Motion for Steam Engines, W. W. Hailstone, 469,471. Filed June 2, 1891.

An arrangement by which the admission of steam to a cylinder may be stopped by means of an electric current under the control of circuit closers located at a distance.

Electric Elevator. R. Watson, 469,361. Filed Oct. 8, 1891.

An automatic governor controlled by the load upon the elevator, increasing the speed of the latter as the load is decreased and vice versa.

Electrical Atomizer, C. Lightbody, 469,481. Filed Apr. 10, 1891.

Apparatus for Pointing Carbon Pencils, P. Moses, 469,486. Filed Apr. 21, 1890.

Process of and Apparatus for Electroplating the Hulls of Vessels, A. D. Buchanan, 469,538. Filed Feb. 20, 1891.

Process consists in docking the vessel, incasing its hull in a flexible envelope, filling the envelope with a metallic solution, and making electric connection between the solution and the hull of the vessel.

Automatic Advertising Apparatus, W. C. Jennings, 469,652. Filed May 20, 1891.

Apparatus for Stopping Engines, J. P. Tirrell, 469,669. Filed Oct. 24, 1891.

A power-controlling device actuated by an electrically-controlled coupling mechanism.

Railways and Appliances :—

Electric Railway, W. S. Smith, 469,280. Filed Sept. 3, 1891.

Claim 1 follows:

The combination, with a trolley arm, of a frame supporting same, gearing for swinging the trolley arm about a vertical pivot, and a shaft for operating said gearing provided with a handle for the motorman.

Commutator Cleaning Device, W. J Phelps, 469,316. Filed Feb. 7, 1891.

Provides means whereby a street car operator can conveniently clean the commutator without leaving his position at the end of the car.

Overhead Conductor for Electric Railways, E. M. Bentley, 469,353. Filed Sept. 17, 1881.

Railway Signaling Apparatus, F. I. Myers, 469,438. Filed July 9, 1891.

Has for its object to clear a signal immediately on the last wheel of the train leaving the block, irrespective of the length of the train.

Brake for Electric Cars, E. S. Amrock, 469,383. Filed Aug. 10, 1891.

Claim 1 follows:

In the combination with a car provided with and operated by an electric motor, a hydrostatic brake, and a connection between the brake and the motor for automatically breaking the circuit of the motor when the brake is applied.

Switches and Cut-Outs :—

Automatic Disconnector, A. L. Johnston, 469,258. Filed Sept. 10, 1891.

A disconnector for railway lighting circuits.

Telegraphs : -

Electric-Telegraph Apparatus, J. Robinson, 469,273. Filed Jan. 21, 1891.

An apparatus by which the movements of a transmitting handle indicating communications from the transmitter, may visibly be reproduced by the duplicate movement of a pointer corresponding to that of the transmitting handle.

Telephones and Apparatus:—

Telephone Support, H. V. Hayes, 469,474. Filed June 22, 1891.

Signal Device for Telephone Pay Stations, W. Gray, 469,649. Filed Apr. 16, 1890.

A coin channel and guide and a signal sounding device having a part located in the path of movement of the falling coin.

Signal Device for Telephone Pay Stations, W. Gray, 469,650. Filed Dec. 15, 1890.

Similar in its object to No. 469,649.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 2, 1892.

Alarms and Signals :—

Non-Interfering Fire-Alarm Telegraph Box, F. F. Loomis, 469,745. Filed Aug. 31, 1891.

Electric Alarm Clock, J. Yungbauer, 469,802. Filed June 22, 1891.

Conductors, Conduits and Insulators :—

Underground Electric Conduit, E. P. Robbins, 469,723. Filed Feb. 24, 1890.

An underground electric conduit simple and inexpensive of construction, generally applicable to all kinds of roadways, convenient of access and as nearly as possible water-tight.

Distributing Box for Cable Systems, C. H. Wilson, 469,765. Filed Sept. 19, 1889.

Conduit System for Electric Railways, J. E. Waller and E. Manville, 469,828. Filed May 13, 1890.

Claim 7 follows:

In combination with a flexible conductor in a conduit, a collecting arm and shank detachably secured to one another by suitable attachments, said attachments engaging through slots in one of said parts and adapted to be disengaged at will.

Insulator, C. N. Hammond, 469,940. Filed Sept. 30, 1891.

An insulator having a straight recess to hold the wire and a curved slot leading into the recess for the introduction of the wire.

Distribution:—

System of Electrical Distribution, W. Stanley, Jr., 469,809. Filed Aug. 15, 1888.

Employs a dynamo generating alternating current and a number of converters to transform the current from one potential to another in a secondary circuit in which the lamps or other translating devices are included.

Dynamos and Motors:—

Device for Controlling Electric Motors, A. L. Parcelle, 469,712. Filed Mar. 14, 1891.

An arrangement by which the circuit may be closed quickly through the field coils and gradually admitted to the armature coils as the proper counter-electromotive force is being developed.

Dynamo-Electric Machines, E. A. Sperry, 469,725. Filed Jan. 10, 1890.

A rotating shaft with an annular armature, rods passing through the same, a supporting spider for such rods, said rods flattened at the point or points where the armature coils pass them, and a field magnet.

Electromagnetic Machine, R. Lundell, 469,862. Filed Aug. 5, 1891.

Claim 1 follows:

The combination of a disc armature and a double field magnet having a set of positive and negative poles on each side of the disc armature, each set of pole-pieces being magnetized by a single magnetizing coil.

Apparatus for Illuminating Cars of Cable Roads, C. E. Scribner and E. P. Warner, 469,873. Filed Oct. 13, 1891.

A dynamo placed upon a cable car and operated by gearing to the axles of the car.

Commutator Brush and Holder, C. D. Jenney, 469,806. Filed Jan. 16, 1891.

Armature Winding for Dynamo-Electric Machines, R. Eickemeyer, 469,917. Filed June 1, 1891.

A low tension winding composed of bendable metal in one or more separate lengths or strands and shaped in the form of a loop having a straight long side, a straight short side, and correspondingly curved ends, which are offset centrally in opposite directions.

Dynamo or Motor, R. C. Kintzing, 470,057. Filed Oct. 13, 1891.

Consists of a hollow spherical shell containing the field magnet cores, removably attached to the shell, and a spherical armature core.

Motor, La M. C. Atwood, 470,095. Filed Sept. 1, 1890.

A motor for street cars employing hydraulic gears.

Galvanic and Thermo-Electric Batteries :—

Electric Battery, E. Ortelli, 470,073. Filed Sept. 18, 1890.

Based upon the property which bromine, chlorine, fluorine and iodine have of uniting with hydrogen and forming strong acids soluble in water, which attack almost all metals and produce hydrogen.

Voltaic Battery, H. I. Harris. 470,123. Filed Apr. 4. 1891.

An improved construction of primary battery by means of which a non-fuming solution in the carbon cells may be used.

Heating :—

Electrically Heated Smoothing Iron, W. Mitchell, 469,792. Filed May 27, 1891.

Electric Soldering Tool, J. J. Ritter, 469,949. Filed Aug. 27, 1891.

Lamps and Appurtenances :—

Extension Electrolier, C. Deavs, 469,895. Filed Nov. 23, 1891.

Electric Light Attachment for Lamps, R C. Putnam, 470,008. Filed Sept. 5, 1891.

Measurement :—

Electric Meter, J. J. Wood, 469,800. Filed Oct. 27, 1891.

An electric motor driven by the current to be measured and a magnetic retarder consisting of a conducting cylinder revolving in inductive proximity to magnetic poles approaching it exteriorally.

Metal-Working :—

Electric Link-Welding Machine, C. L. Coffin, 470,038. Filed Apr. 25, 1891.

Miscellaneous :—

Electromagnet, A. D. Ayres, 469,672. Filed May 23, 1891.

A series of paramagnetically-encased coils bound together and a series of paramagnetic armatures magnetically separated and bound together, and a commutator whereby the successive energizing of the coils produces a prolonged movement of the magnets and armatures.

Galvanic Electric Plaster, J. W. Shults, 469,796. Filed May 16, 1891.

Galvanic Electric Plaster, J. W. Shults, 469,797. Filed June 29, 1891.

Electrical Releasing-Device for Target-Traps, P. North, 469,905. Filed May 6, 1891.

Method of, and Apparatus for, Rating Watch-Balances, C. E. Emery, 469,967. Filed Apr. 10, 1891.

Lightning Arrester, C. F. Scott and A. Wurts, 470,018. Filed July 17, 1891.

A discharge plate connected with one side of a circuit and a second discharge plate connected with the earth, and apparatus to bring said plates into proximity at rapidly-recurring intervals.

Adjustable Suspension Apparatus for Electrical Translating Devices, H. D. Sisson, 470,080. Filed Sept. 24, 1891.

Automatic Valve-Controller, W. H. Kilbourn, 470,143. Filed Dec. 18, 1890.

Electrical Device for Stopping Horses, A. B. Holson, 470,155. Filed Feb. 14, 1891.

Electric Elevator, C. J. Sturgeon, 470,158. Filed Jan. 27, 1891.

Circuit-Interrupting Device, A. Wurts, 470,161. Filed Apr. 23, 1891.

A complete shunt circuit of high resistance around the contact points of the main circuit interrupter, causing its connection to be severed subsequently.

Railways and Appliances :—

Automatic Trolley Catch, S. A. Shepard and F. P. Lang, 469,750. Filed Aug. 7, 1891.

A trolley catch having a ratchet and pawl, a wedge adapted to engage the pawl, a strap which bears on the wedge and means for winding a spring connected with the ratchet.

Electric Locomotive, T. L. Willson, 469,799. Filed July 3, 1891.

An electric motor having great traction power adapted to very heavy work, steep grade, etc.

Contact Device for Electric Railways, J. C. Love, 469,861. Filed June 16, 1891.

An arrangement for maintaining a constant pressure of the trolley wheel upon the wire.

Railway Station, J. G. Emery, Jr., 469,882. Filed March 30, 1891.

Claim 1 follows:

In devices for operating a movable railway station, arranged to travel on a side track alongside of a moving train on a main track, an electricity-generating device on the train on the main track adapted to supply electric motive power to the auxiliary train on the side track.

Trolley for Electric Railways, W. H. Morgan, 469,899. Filed June 24, 1891.

Has for its object to provide means whereby the wearing parts of the trolley can readily be replaced when worn.

Electric Railway Signal, W. Holloway, 470,129. Filed Aug. 21, 1891.

Switches and Cut-Outs :—

Fuse for Electric Circuits, C. F. Scott and A. Wurts, 470,014. Filed Oct. 16, 1891.

A fuse having great carrying capacity, low melting point, small mass and which will not deteriorate.

Telegraphs :—

Telegraph Apparatus for Branch Offices, J. B. Hurd, 469,856. Filed March 7, 1890.

Adapted to connect local stations with the main line at a central office so that a local operator may have the means of communication with the central office to inform the latter of line trouble which he may detect.

Telephones and Apparatus :—

Telephony, W. C. Lockwood, 469,706. Filed Sept. 29, 1891.

A combination of the horseshoe magnets with opposing poles, the coils in one being in a local circuit embracing a battery and transmitter and the coils in both being in circuit with the main line and ground.

Telephone Transmitter, J. C. Goulding, 469,782. Filed June 12, 1891.

A transmitter that may be placed at any desired height for the convenience of the user.

Electromagnetic Annunciator, F. W. Dunbar, 469,995. Filed Nov. 23, 1891.

A visual annunciator for telephone systems.

Telephone System, T. W. O'Brien, 469,865. Filed Nov. 12, 1890.

Has for its object to enable all signals to be transmitted by means of a single signal transmitter common to the whole system.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT

In advertising, don't try to make an incandescent lamp do the work of an arc.

THE "P. & M." AUTOMATIC ELECTRIC DROP LIGHT.

A LINE of very interesting and useful novelties just put upon the market by the Southern Electric Company, of Baltimore, Md., are destined to improve the present methods of electric light installations and add to their convenience and beauty. The improvements are quite marked over the present methods and fixtures, and a brief description will be found of interest. The "P. & M." automatic electric drop light illustrated herewith in Figs. 1 and 2 is designed to supersede complicated and expensive fixtures, whose delicately balanced system of pulley and weights has made their use of limited extent. The drop light, broadly speaking, consists of a drum and its attached lamp cord, running in grooves to insure precision; the whole fixture with its ornamental brass trimmings, is a credit to its makers, while its small size and neat appearance add greatly to its attractiveness.

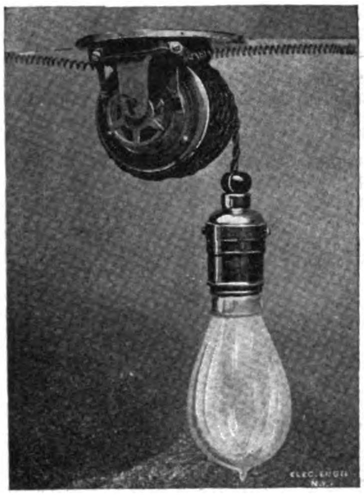


FIG. 1.—THE "P. & M." AUTOMATIC ELECTRIC DROP LIGHT.

The mechanism is that of the ordinary spring roller used so extensively on window curtains; the certainty of its action having been so thoroughly demonstrated any comment is unnecessary beyond noting the superior finish and adjustment of the different parts.

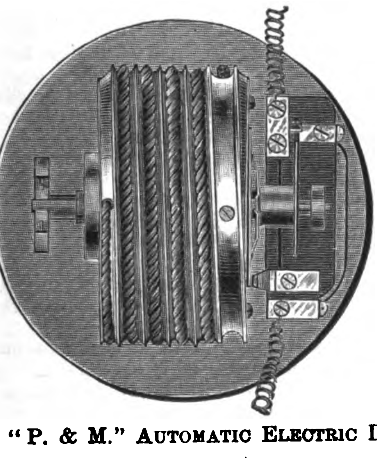


FIG. 2.—THE "P. & M." AUTOMATIC ELECTRIC DROP LIGHT.

Only one size of cord and drum is made at present; any change in the size of lamp or style of shade may be made at pleasure; the inconvenience of adding or subtracting weights so as to balance the parts having been entirely done away with.

If, in its normal position, the lamp is supposed to hang with the current turned off and it be desired to light it, any downward motion of the lamp releases the switch carried by the roller and turns on the current. If, on the other hand, it is desired to put out the light, the slightest upward impulse is sufficient. The mechanism is thus direct and positive and not liable to get out of order, the current is under perfect control by the slightest motion of the hand, and the lamp capable of any desired adjustment as to its position.

A double-pole cut-out is located under the roller block and is a complete protection against any abnormal increase of current. The perfection of the device leaves little to be desired, and we recommend it to the consideration of the trade.

The cuts shown are one-half size. Mr. G. E. Painter, the electrician of the company, is the inventor.

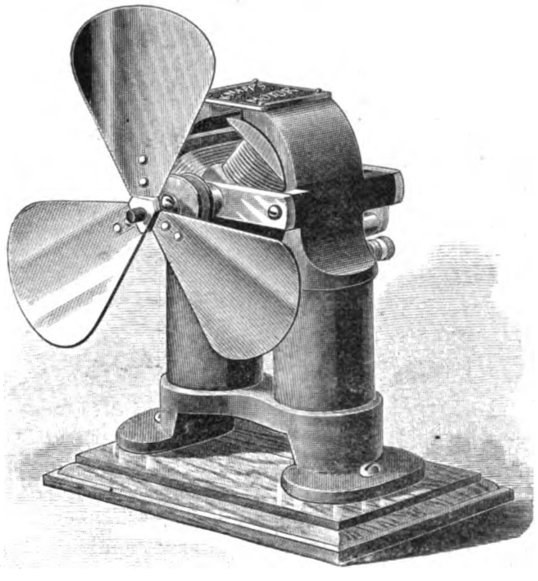
THE "STORELECTRO" CAR.

ON Saturday, February 29, the first public trial trip was made of the new storage battery car built by the Ford-Washburn Storelectro Co., of Cleveland, Ohio, and proved eminently successful. The car is 26 feet in length over all, and carries 180 cells of battery placed under the seats, operating a 40 h. p. Ford-Washburn motor. With this equipment a loaded trailer was drawn up a 1½ per cent. grade at the rate of 15 miles per hour. On an ordinary track one charge it is claimed will last for 50 miles.

Superintendent George Mulhern, of the Woodland Avenue and West Side Street Railroad Company, who was on the car at the time of the test, was very favorably impressed with the result. The system, he says, will probably be adopted by his company, and, meantime, the experimental car, the "Ideal," will make regular trips on the road.

THE KNAPP FAN MOTOR.

WE illustrate herewith the Knapp motor for light work, just put upon the market by the Knapp Electric and Novelty Co., of 34 Warren street, N. Y. It stands 6 inches high, and with a 6-inch fan weighs less than four lbs. The binding posts to circuit are not, as usual, on the wooden base but are on the iron of the magnetic circuit, and well insulated. In this manner, it is made easy to remove the motor from its ordinary base and to fasten it to the edge of a desk or table, when, of course, a fan of much larger diameter can be used. The motor is sent out, however, mounted on a neat mahogany stand, to which it is secured by a neat iron pedestal. The motor is carefully finished in enamel, and has full brass trimmings, being a good piece of work all through. The present size, with fan, is being marketed at $5. It will run with any of the ordinary motor batteries, and appears to be quite economical of current.



THE KNAPP FAN MOTOR.

SEBASTIAN LATHE CO.

THE new catalogue of the Sebastian Lathe Co., of 41, 43 and 45 Central avenue, Cincinnati, O., contains a very complete list of lathes for both metal and wood working, planers, drills, shaping machines, power saws, shafting, hangers, and mechanics supplies of every conceivable nature. In addition to this, the catalogue contains a list of useful books for mechanics and amateurs.

CHEAPER ALCOHOL FOR MANUFACTURING PURPOSES.

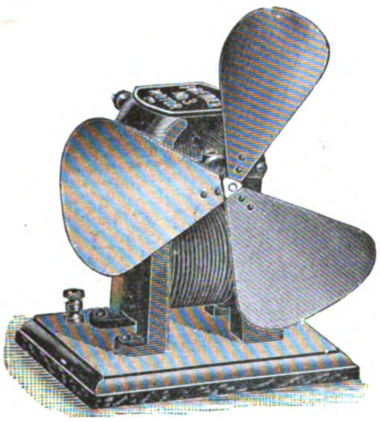
THE recent discovery of a new process alcohol for use in the arts by Prof. Wm. Read, of Needham, Mass., is worthy of notice. For many years the consumers of alcohol for manufacturing purposes have labored under the disadvantages of a heavy revenue tax and the high rates set by the whiskey trust, having only as a substitute the foully smelling wood alcohol or the fouler fusil oil, which was a poor one at the best. Several years ago Prof. Read in his chemical researches discovered a formula and process which, carefully perfected, has, it is confidently asserted, opened a field as wide as that which lay before the discoverers of the oil territory.

The spirit manufactured under his process is pure and colorless and in its properties is exactly identical with the spirit in present use except that its "cutting" or solvent properties are far more active than those of the spirits at present on the market. One of its greatest values appears to lie in the immense saving it will make by redissolving spirit varnishes which have become thick, dry or positively hard from exposure to the air by careless workmen, large quantities of which varnishes are used by electric manufacturing companies for insulating purposes.

Its burning properties are identical with those of pure grain alcohol. The Massachusetts Chemical Co. has been organized to handle this new chemical, and they are now erecting laboratories sufficient to supply the enormous demand which has already arisen for their product.

THE PREMIER ELECTRIC MOTOR.

WE illustrate on this page the No. 2 Premier electric motor, built by the Premier Electric Co. of 11 Whipple street, Brooklyn, who are building up a large business in these motors and in batteries to run them. This little motor is made of the best soft iron, enameled, carefully insulated and wound with the best double-covered wire. It has small oil cups on its bearings, a brass driving pulley, binding posts, etc., and easily adjustable brushes. It carries a 5-inch fan. The No. 3, size takes a inch fan; and the concern are now building a dainty little No. 1, which will have a small but effective fan, to sell at $3. It is interesting to note the rapid stages by which improvements in small motor manufacturing have reduced the price to the point where it seems impossible that anybody who wants relief from the heat will refuse to buy.



PREMIER ELECTRIC MOTOR.

The Premier Co. are now building a two-story factory at 17 and 19 Whipple street, which they expect to occupy before April 1, and where they will manufacture not only their motors but the Premier Grenet and Premier carbon batteries They expect also to put on the market shortly an improved dry battery, learners' telegraph instruments and a number of popular electrical novelties. The company to-day is a copartnership composed of Mr. A. Rodrigues, Mr. M. R. Rodrigues, a well-known electrician, and Mr. E. F. Kelly, manager of the sales department.

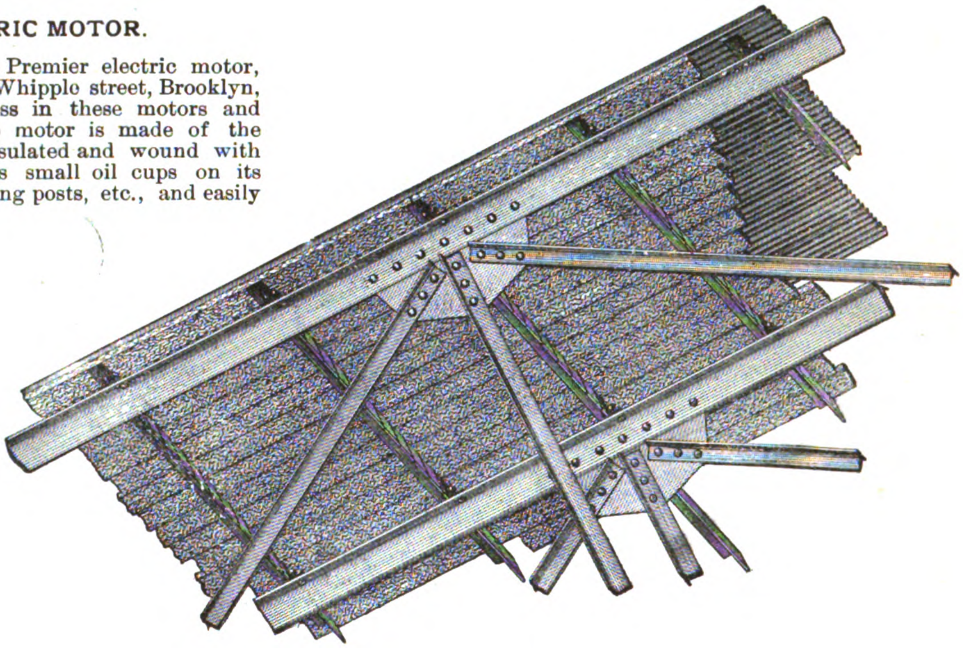
THE JOHNSON STANDARDIZING CO.

THE JOHNSON STANDARDIZING COMPANY is a new corporation organized to own and control, for the purpose of greater convenience, the manifold inventions, contracts, experimental work and general electrical properties heretofore owned or controlled individually by Mr. Edward H. Johnson. Mr. Johnson's personal operations in the way developing and marketing not only his own inventions but those of numerous young inventors who have turned to him for help and advice have become so extensive that it was found advisable in many ways to assign them all to a small close corporation, the stock of which is, of course, owned almost wholly by Mr. Johnson himself.

MACKITE PLASTER BOARDS IN ELECTRIC LIGHT STATIONS.

WITH the experience gained during the last ten years, central station construction has made great progress, and in no detail is this more marked than in the precautions taken to make stations of as fireproof a character as possible. While some of the materials of which such a building is composed may be combustible, much can be done towards reducing the fire risk by the application of protective materials, which are designed to prevent the fire from getting at the timbers and beams.

One of the most interesting and valuable materials of this kind is that known as the Mackite plaster board, which has already gone into extensive use in this country after having been in use abroad for a long time. These Mackite plaster boards, which are made by the Eastern Plaster Board Co., of 52 Broad street, this city, are generally four feet long. Reeds of the same length are placed in the molds in which the boards are made, a mixture of water, plaster-of-paris, fibre, ground cork, etc., which is used, being poured over them, and worked around them, so that when the board is dry the reeds shall be nowhere exposed. The reeds give the boards longitudinal strength, enabling them to be used and handled in these lengths; the fibre makes the boards tough, elastic and strong transversely; the cork waste increases their sound-deadening qualities, while the plaster-of-paris makes them a solid fireproof board, furnishing the rough base for the hard finish coat which is applied to them after they are nailed in position.



"MACKITE" PLASTER BOARD ROOFING.

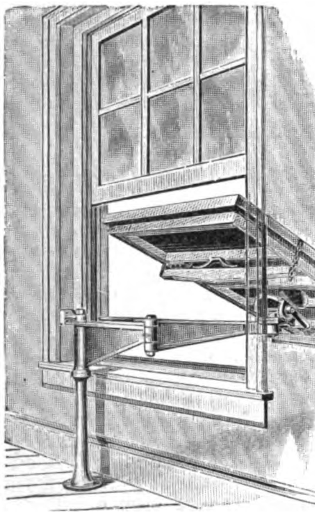
The boards are easily and rapidly nailed in place, tinned wire nails with large heads being used. As soon as the joints between them are filled with plaster, the skin or hard finish coat may be applied, and, as this dries quickly, the building is immediately ready for occupancy. Boards of three-quarters of an inch and one inch in thickness are generally used to take the place of lath and plaster, but Mackite is also made in the form of planks of all thicknesses and of hollow blocks of various sizes. Another good feature of Mackite is that it is not only a non-conductor of sound, but is readily and cheaply applied in the form of blind or intermediate floors, hollow partitions, etc., for purposes of sound deadening.

Mackite, being a non-conductor of heat, prevents the condensation of moisture on the inside of iron roofs. It is, therefore, specially adapted for electric light stations, and has been applied in such situations in a number of places. The accompanying engraving shows the manner of applying the Mackite board lining to a corrugated iron roof as built by the Berlin Iron Bridge Co. The fastenings holding the sheets of corrugated iron pass directly through the boards, securing them in place also.

THE THOMSON-HOUSTON MOTOR COMPANY, of Boston, have recently added a ventilating engineering department, and will use exclusively hereafter the Davidson fan, made by the Davidson Ventilating Fan Company, of Boston. This form of fan has been adopted after exhaustive tests, and will be used in conjunction with their own well-known type of motor.

SOLAR PRINTING FRAMES.

The Philadelphia Engineering Works, Limited, of Mifflin street, Philadelphia, have recently introduced an improved form of blue print frame, shown in the accompanying illustration, which possesses a number of valuable and distinctive characteristics. As will be seen, the frame is supported upon a single standard, occupying no appreciable floor space, and may be folded back against the wall when not in use. The frame is so mounted at the end of the supporting arm that it can always be placed in position to catch the rays of the sun in a direction normal to its surface at any hour of the day. It is strongly though lightly made of well-seasoned white pine, and will, no doubt, become deservedly popular.

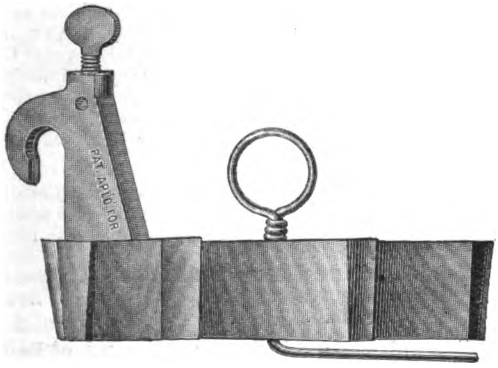


A Solar Printing Frame.

THE DELANY CROWFOOT ZINC.

The E. S. Greeley & Company have become the sole licensees for the manufacture and sale of the new zinc shown in this cut, the invention of Mr. P. B. Delany. The zinc itself is just like the ordinary crowfoot zinc in common use, but Mr. Delany has added a very simple and effective means for removal of the stalactite formations of spongy copper which grow on the under side and hang down into the copper solution, thus setting up local action and causing great waste of zinc and bluestone.

The device scarcely needs description. A glance at the cut will show a wire sweep through the central toe of the zinc. The wire is bent on a horizontal plane with the zinc, so that by touching the eye-end projecting above the solution the sweep is free to move in either direction so as to thoroughly sweep or brush the entire bottom of the zinc from centre to circumference, thereby sending all the spongy coating to the bottom of the jar. Heretofore this operation has been attended with so much difficulty that it was either imperfectly done or neglected altogether.



The Delany Crowfoot Zinc.

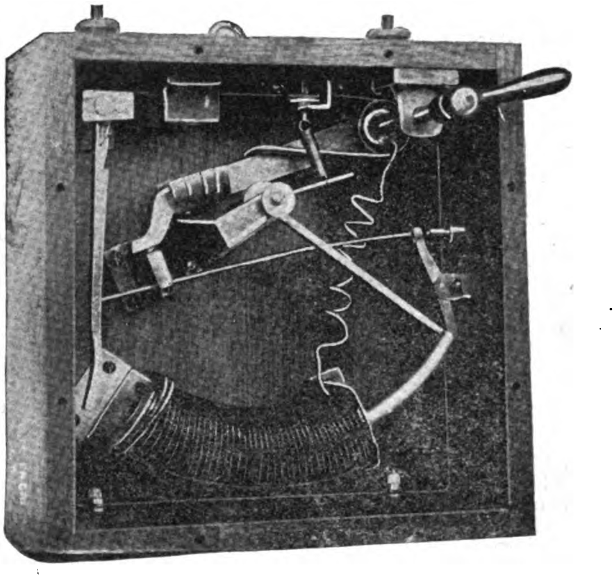
The careful battery-man or operator who has angled in a gravity cell with a piece of bent wire, smutching his fingers and twisting his neck trying to dislodge an inaccessible pendant, will welcome this simple improvement which will enable him to clean off a thousand zincs in a few minutes without splashing the shelves or his clothes. With this improvement it will not be necessary to disturb zincs from the time they are placed in the battery until entirely used up.

Besides the great saving effected in zinc and copper, the resistance and efficiency of all the cells of a battery will be uniform, as the laziest or most careless attendant will not fail to give the sweep an occasional twist.

As we understand that the nature of the device is such as to add little or nothing to the cost of the zinc, we see no reason why the Delany form of crowfoot zinc should not become a standard.

THE NEW DEAN AUTOMATIC CUT-OUT.

The accompanying illustration shows a new design in automatic cut-outs that has recently been designed by Mr. J. H. Dean, of St. Paul, Minn. The instrument is so arranged that the current passing through the solenoid attracts a core which is attached to an arm about which it swings. When the current exceeds a certain limit, the core is drawn into the solenoid, and raises a lever which in turn releases the switch and opens the circuit. If, as in the case of stationary motors supplied from central stations, the current is suddenly cut off when changing from one machine to another, the circuit is automatically opened by the tension spring. This engages the small lever by withdrawing the core from the solenoid and raising the lever, which in turn releases the switch. The tension spring is so arranged that it can be made to open the circuit for any predetermined amount of current. One of the main features of the cut-out is that it does away with all fuses, which are usually a large item in connection with central stations, and it may be relied upon to act at stated amounts of current. It can readily be applied to railroad circuits by using magnetic blow-outs at the switch contact. The cut-out has been given practical tests and found to work very satisfactorily in all cases.



The New Dean Automatic Cut-Out.

THE STORAGE BATTERY SUPPLY CO.

The above company are the agents of the Consolidated Electric Storage Co. of this city, and have offices at 120 Broadway, with works at 158 West Twenty-seventh street. They are making a specialty of supplying stored current for all purposes, whether for special or regular work such as running phonographs, automatic machines, small lathes, portable lamps, etc. We referred recently to a small portable lamp of theirs (page 205, of this volume), and are glad to refer to it again as a very handy little equipment. The lamp is encased with a glass shield, has a reflector, and derives current from the battery box on which the reflector is mounted. The business is under the active direction of T. D. Bunce, Jr., and R. S. Vorhees.

UNDERWOOD COTTON LEATHER BELTS.

Touching the Buffalo Convention, it should be noted that the Buffalo Street Railway Company's consolidated lines have just ordered three 24-inch Underwood cotton leather belts for their power station. These are in addition to the four cotton leather belts of same make and size now running at this station. These and other Underwood belts running in Buffalo were inspected and found to be doing exceedingly well. The Iroquois and Broezel hotels are equipped with them, and guests of these houses who were attending the Convention were shown the practical working value of the Underwood belting. The Buffalo belts were purchased through the Engineering Equipment Company, who have full control of the Underwood trade in New York State, from their offices, 143 Liberty street, New York City.

THE NEW V. V. CEILING PENDANT CUT-OUT.

ANOTHER new form of ceiling cut-out has recently been added to the long list of special and improved devices now upon the market. The article in question is a development of a design by Mr. J. Van Vleck, electrician for the Edison Electric Illuminating Co., of New York, for whose special requirements it was originally made. Mr. Van Vleck has succeeded in embodying in one block of small dimensions all the desirable features that such an appliance should possess.

The cut-out is adapted to both exposed and surface work. In the latter case the wires are brought directly through the base to the binding posts and do not appear on the outside of the cut-out. It has a square base and consequently is especially adapted to moulding work.

The interlocking contacts are substantially made and of such a character as to permit of no loose connections or the liability of the same working loose. Double-pole safety catches are concealed in the cover, permitting easy renewal without disturbing the base of the block, and the room for making connections is not cramped.

Possessing no external binding posts nor metal parts, the block has naturally found favor and received the endorsement of the Fire Underwriters. The block is known as the "V. V." ceiling cut-out, and a close inspection or trial will readily demonstrate that the claim of the manufacturers, the Interior Conduit & Insulation Company, that it is sure to meet with approval.

PHILADELPHIA NOTES.

MESSRS. J. W. PARKER & CO., Philadelphia, agents for the Ball engine and C. & C. motor, report the following installations: North Hudson Elevated Road, Hoboken, N. J., one 250 h. p. railroad Ball engine; Leesburg, Va., Electric Light Company, one 60 h. p. compound Ball engine; Doylestown Electric Light Co., Doylestown, Pa., one 125 h. p. standard Ball engine. C. & C. motors—Edgemoor Bridge Works, Wilmington, Del., one 15 h. p. special motor; Wm. Sellers Co., Philadelphia, one 7½ h. p. special motor; Winifrede Coal Co., Winifrede, Va., one 8 h. p. special motor; Delaware Electric and Supply Company, Wilmington, Del., one 5 h. p. motor; Sternberg & Co., Philadelphia, one h. p. motor; Novelties Mfg. Co., Philadelphia, one 2 h. p. motor; Harding & Dubois, Philadelphia, one 7½ h. p. motor; Assembly Building, West Chester, Pa., one 1 h. p. motor.

THE ISOLATED LIGHTING DEPARTMENT of the Thomson-Houston Electric Co. has been merged with the general department of that company in order that it might bear the same relation to that company that the other lines of electric work enjoy. All isolated work is now conducted through the general department. Mr. C. K. Westbrook, the former manager of the isolated department, still remains with the company in the capacity of salesman in both central station and isolated work.

THE LA ROCHE ELECTRIC WORKS have just issued a handsome catalogue of over 50 pages, finely illustrated and giving a full description of their arc and incandescent lighting machinery and instruments which they make in large variety. It also gives many testimonial letters from those who are using the La Roche system.

THE RIES ELECTRIC SPECIALTY CO., of Baltimore, are driven to their utmost capacity in filling orders for their regulating sockets. They have just established an agency at Helsingfors, Finland, Russia, and are communicating with parties in different countries, all of which is the result of their advertising in THE ELECTRICAL ENGINEER

MR. ARTHUR L. BOSLEY, of the Pennsylvania Electric Engineering Co., and Miss May A. Turner were married last week at the home of the bride, 1924 Girard avenue. Owing to the recent death of the bride's mother, none but the immediate family was present. Mr. Bosley and bride are making an extended tour North.

MR. EDWARD R. GRIER, formerly of the expert department of the Thomson-Houston Electric Co., of Lynn, Mass., has opened an office at 501 Girard Building. Mr. Grier will make a specialty of construction work, and will also act as agent for several well-known manufacturers of electrical supplies.

MR. F. A. LA ROCHE, general manager of the La Roche Electric Works, has recently returned from a three weeks' business trip through the West and South to Cuba. Mr. La Roche closed some important contracts during his absence and reports a bright outlook.

W. H. WESTON & CO. have just finished some very fine switchboards, among which was one for the Tucker Electrical Construction Co., of New York, and several for a concern in Maine. The demand for their railroad switches continually increases.

THE WASHINGTON ELECTRIC CONDUIT CO. have orders for their terra-cotta conduits to be laid in Washington alone which will amount to over $50,000. Several other cities have adopted the terra-cotta conduits.

THE PENNSYLVANIA ELECTRIC ENGINEERING CO. has just closed a contract with the Milville (N. J.) Electric Light Co. for a 500-light National alternating dynamo.

NEW ENGLAND NOTES.

THE COMBINATION CAR COMPANY, of 23 Court street, Boston, was organized some time ago for the purpose of manufacturing a combination car; or, in other words, a car which would be suitable either for winter or summer purposes. At present street railway companies are obliged to have two sets of cars, one for winter and another for summer use, which necessarily involves a large expenditure of capital, not only for the cars themselves but for their storage when not in use. The combination car is instantly transposable from a winter to a summer car, by means of an ingenious system of windows, which can either be opened or closed. The seats are all placed across the car, and access is had to them by a passage running up the centre of the car, so that passengers require to get on and off at the ends, which is a decided advantage, as it eliminates all danger from stepping off in front of an approaching car. One of these cars is now nearly ready for use, and will soon be seen in the streets of Boston. The company's officers consist of Mr. Frank Chandler, president; Mr. Wm. H. North, vice-president; Mr. Gilman B. Bolton, treasurer, and Mr. G. C. Hoyt, secretary.

THE AMERICAN CIRCULAR LOOM COMPANY, of Boston, have recently added to their justly-celebrated product of canvas-jacket wires, the manufacture of a flexible tubing for interior wiring which seems to have great merit, and was fully described in a former issue of THE ELECTRICAL ENGINEER. They have lately been experimenting, with very flattering results, with the same tubing, protected with a lead covering, for underground and submarine work, and seem to be in a fair way of obtaining what everyone is looking for—a cheap and efficient underground conduit.

S. C. NIGHTINGALE & CHILDS, of Boston, Eastern agents for the Magnesia Sectional Covering Company, of Ambler, Pa., have received a contract for covering the steam pipes, etc., of the new electric light station at Brookline, Mass., and will also cover with magnesia all the new pipe-work now being installed in the station of the Boston Electric Light Company. They are also covering the four Manning boilers and the cylinders of the Greene compound engine, now being installed by the Thomson-Houston Company, at Lynn, for testing their large power generators.

THE BOSTON BRAID MANUFACTURING COMPANY, of 28 Beach street, Boston, are making a specialty of fine silk braid for the manufacture of filaments for incandescent lamps, and have scored a decided success in this line. Quality and uniformity are absolutely indispensable, and Mr. Fieldler, the general manager of the company, reports that judging from the demand for his goods, they appear to have given the highest satisfaction.

THE RHODE ISLAND BRAIDING MACHINE COMPANY, of Providence, R. I., have recently supplied the Electric Supply Company, of Ansonia, Conn., with several of their heavy double-deck wire-covering braiders, with a special take-up arrangement for winding up heavy wire. They have also supplied recently several of their special taping machines to various manufacturers of insulated wires.

MR. F. L. LENOIR, superintendent of the Worcester Consolidated Street Railway, reports all but twenty-one miles of the entire road equipped, and work on this is progressing rapidly. He has just returned from a short Western tour of inspection. The Worcester, Leicester and Spencer Railway have recently added a 100 h. p. multipolar generator, which works with five bi-polar dynamos of 80 h. p. each.

THE THOMSON-HOUSTON ELECTRIC COMPANY, of Boston, have recently received the order from the Brooklyn Street Railway Company for 600 complete car equipments, comprising 1,200 motors in all.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

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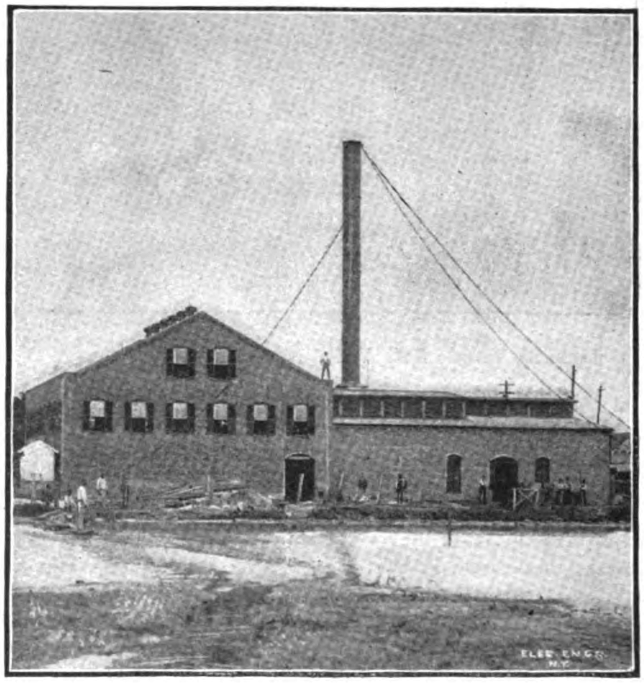
ELECTRIC LIGHTS ON A CORAL REEF.

Part of the Staff.

THE installation of an electric light plant at Key West, Fla., has attracted considerable attention in electrical circles, from the fact that it is the southernmost plant in the United States, and is built on a coral reef. Key West lies in lat. 24° 32′; a mere speck of rock begirt by the blue waters of the Gulf, almost unknown to the rest of the world, and the very end of the United States. The Key has been settled about seventy years, and during that time has grown from a small hamlet of fishermen to a city of 23,000 people. The inhabitants consist of Cubans, negroes, Conchs and Americans. The Cubans are cigar makers; Conchs, sponge fishers and wreckers; and the negro, with his elastic make-up, covering a wide range of occupations, some of them useful mechanics, a few utilized as policemen, while a large majority do an immense amount of arduous "sitting around." The Americans are endeavoring to lift the city out of the old-time rut by improving the condition of things in general.

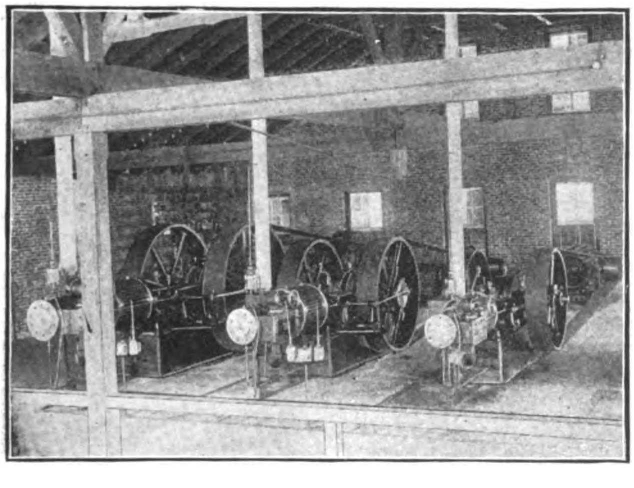
Through the efforts of the latter class of citizens, the lighting of the town in a civilized manner has been accomplished. Some years ago a franchise was granted, and a company formed known as the "Key West Gas and Electric Company," who erected a small gas plant, using petroleum, from which gas was manufactured. This went into operation in 1884. The question of installing an electric plant was brought up from time to time, and in order to hold the franchise a few poles were set. Through the efforts of Mr. John Jay Philbrick, a local merchant, an extension of time was granted, and, after buying up nearly all the shares of the company and making a careful examination of the different systems of electric lighting, Mr. Philbrick, in the early part of 1891, gave the Thomson-Houston Electric Company, through their Atlanta agent, Mr. Hiram Ogle, an order for the electric plant, and the Ball Engine Co. of Erie, Pa., for the steam plant. The lighting plant called for was one 50 light 10 ampere arc dynamo, with lamps of 2,000 c. p.; one 650 light, and one 1,500 light compound wound alternating dynamo, for lamps of 16 c. p. with all the necessary appliances and fixtures.

The steam plant consists of three Ball condensing tandem compound engines of the latest improved pattern, one of 65 h. p., one of 110 h. p. and one 165 h. p., one Otis heater of 300 h. p., one Wheeler surface condenser of 300 h. p., one Davidson air pump and fresh-water pump, one Keating injector, two steel boilers 150 h. p. each. A brick building, 62 x 45 feet, was erected in which to place the machinery. But here the first difficulty presented itself. A pit 10 feet deep was required for the heater, condenser and pumps, but this was found impracticable on account of the friable nature of the coral rock, through which the water bubbled up without interruption. It would require a powerful steam pump to keep the pit clear while it was being dug, and costly masonry to keep the water out after it was dug. The rock could only be worked with pick and shovel; blasting had but little effect on account of it being very soft and offering no resistance. The plans were changed. An additional brick building, 80 x 60 feet, was built, in which the engines and dynamos were placed on foundations 10 feet high, of hard brick, resting on the coral rock, and with a small amount of earth filling, making a solid mass of masonry 36 x 40 feet and 10 feet high. On the top of this mass of masonry and earth filling was spread grouting of broken stone and cement six inches thick, and finished with a graniteoid floor 1¼ inch thick. This brought the heater, condenser, pumps and hot-well on a level with the floor of the first building (which was used for a boiler house) between the engine foundation and partition wall. In front of the condenser a salt well, 18 x 18 feet and 5 feet deep was dug in the rock, from which the water supply for the circulating pump was drawn. From this to a salt-water pond, on Government land 100 feet west of the station, a canal was dug through the rock to the pond, which covered about three acres and was connected with the sea. The depth of water in the pond was 13 inches at low tide. Spread over the bottom of the pond was 23 inches of silt. A channel 10 feet wide was dredged through the pond and the inlet from the sea deepened. A tide gate placed in the inlet allowed the tide to enter



POWER HOUSE; KEY WEST ELECTRIC LIGHT PLANT.

the pond and closed on the ebb, giving a depth of about 25 inches of water at low tide, an ample supply for condensing purposes. The top of the boiler house floor was but 23 inches above the high-water mark located on the beach. While digging the salt-water well the water ebbed and flowed with the tide, although over 100 feet of rock lay between the well and pond which was affected by the tide. The distance from the station to the sea proper was 1,100 feet. There is no fresh water on the island except what is collected from the roofs, stored in stone cisterns and sold at one and a half cents per gallon. As no cistern had been built for the use of the station, and it was necessary to have enough fresh water to make up for the waste and fill the boilers after cleaning, the engineer made an examination of the brackish water which could be drawn from the rock at a depth of from three to five feet, and as this water was used for domestic purposes by those who had no cisterns, he concluded to use it until a cistern could be built. It was found that the rock was filled with water from rains, and held back by the dense sea water surrounding the island, and at a level somewhat above the tide marks, ebbing and flowing with the tide. A well four inches in diameter was drilled into the rock and the water tested for salt every foot. At a depth of 20 feet a slight change was noted and the drill stopped. A pipe 18 feet long was dropped in for suction and the boilers fed from this when occasion required. A trace of salt was perceptible in the water, but on the whole it was superior to water used at many places on the main land for boilers. In a trial of two hours' duration, the pump delivered a solid stream through a 1½-inch nozzle without diminishing the supply, showing conclusively that the water flowed through the rock as readily as through gravel. Although a small quantity of this water was used for boiler fuel each day, some scale was looked for, but after twenty-one days' run the boiler was opened and found perfectly free of all earthy deposit, and with the exception of a small amount of oily matter along the water line as clean as when put in service. The fuel was Cumberland coal.



DYNAMO ROOM; KEY WEST ELECTRIC LIGHT PLANT.

The arrival of the machinery was an event in the history of Key West, and was viewed with great curiosity as it came over the steamer's side. The landing of the big boilers created much excitement among the natives, who at once began to speculate on the manner of transportation from the wharf to the station nearly a mile away. Heavy teaming was unknown, consequently there was no truck strong enough to carry the boilers, on the island. They were therefore placed on cradles mounted on skids, and trundled very slowly—about half a mile a day—through the streets on rollers, with the aid of a tackle and a pair of mules. Previous to the arrival of these engines and boilers, the entire steam power on the island amounted to about 15 h. p.

The poles used for the line are cypress, shipped in from Tampa by vessel. As the island is a mass of coral rock, all holes for the poles, with the exception of places once a salt marsh, and now filled in, were dug with steel-pointed bars; costing from seventy-five cents to two dollars each, according to the hardness of the rock. Layers of flint were often struck, and where this occurred an entire day was often consumed in getting one hole down to the required depth. In the lower part of the town which was at one time a salt marsh and filled in, the earth was too soft to hold the poles, and the tide flowing in the gutters of the streets, kept the ground soaked. Barrels were sunk in which the poles were placed, and broken stone was tamped in. The lower end of the poles was coated with asphaltum, and the remainder painted. Twenty-five lightning arresters were placed in different parts of the lines. Kite-flying is one of the amusements, and indulged in as much by grown persons as by youngsters, and in a short time the lines were festooned with all manner of kites and kite-tails, and for blocks at a stretch the wires were pulled together. An ordinance was passed by the city council imposing a fine of $5 against kite-flying, and the police were instructed to arrest all violators. A short time before the plant went into operation, men were sent out, and the lines were cleared. Many schemes were tried to remove the wrecked kites, but the most effective was with a torch on the end of a long pole.

On December 24th last, the engines turned over for the first time. It had been announced some weeks previously that the town would have the lights on Christmas Eve; and a large crowd of people gathered at the station to see if it was possible to make a lamp burn without oil, and with a wick that looked like a piece of iron. At seven o'clock the engines were started, five minutes later the switch was turned, and in an instant the station was in a blaze of light, while cheer after cheer went up from the motley crowd. The light was at once popular, and orders came in so rapidly, that the line force was increased, and lines were extended as fast as possible. The street lighting has been done by private subscription. The price for arc lights is $4.50 and incandescent lamps are fifty cents per week, all-night lighting. The plant has cost about $70,000. It was installed by Mr. H. P. Loring for the Thomson-Houston Co. and Mr. C. W. Hanson for the Ball Engine Co. Almost the entire expense has been borne by Mr. Philbrick, through whose efforts Key West has one of the finest electric plants in the South, and the lighting of a coral reef has been accomplished.

DIELECTRIC HYSTERESIS—THE LOSS OF ENERGY IN A DIELECTRIC MEDIUM UNDER ALTERNATING ELECTROSTATIC STRAIN.

BY

Chas. Steinmetz.

IN a paper read before the American Institute of Electrical Engineers on January 19, 1892, I have proved by experimental data, that the loss of energy in iron and other magnetizable bodies, under alternating magnetic strain, is expressed by the formula,

$$H = \eta B^{1.6},$$

that is, proportional to the 1.6th power of the intensity of the magnetic field.

The analogy existing between the behavior of dielectric bodies in an electrostatic field with that of a magnetic body in a magnetic field suggested that in dielectric media in an electrostatic field, for instance in the insulating medium of a condenser which is alternately charged and discharged, a consumption of energy takes place, which depends upon the intensity of the electrostatic field according to a law similar to that of magnetic hysteresis.

That in the dielectric medium of a condenser, which is connected with an alternating E. M. F., a consumption of energy takes place, is known from the fact that the condenser gets hot, while it does not get hot when connected to a source of equal, but constant potential.

To determine this loss of energy and its dependence upon the E. M. F. I made, towards the end of January, 1892, a number of tests with a condenser of 3 microfarads capacity, with paraffine paper as insulating medium, by connecting this condenser in an alternating current circuit of 170 complete periods per second, and measuring the energy consumed by the condenser, in a similar manner, and with the same apparatus that was employed in the tests on magnetic hysteresis.

After subtracting the energy consumed by the leakage current—which was found by testing with a continuous current of equal E. M. F.,—and the energy consumed by the instruments, it was found that:

The energy consumed by the dielectric medium under alternating electrostatic strain is directly proportional to the SQUARE *of the intensity of the electrostatic strain; that is, proportional to the* SQUARE *of the* E. M. F. *acting upon the condenser;* or, expressed in symbols,

$$H = k E^2.$$

Hence, while the *magnetic hysteresis* follows the law of the 1.6*th power*, the *dielectric hysteresis* follows a simple *law of squares;* that is, it acts just the same as a mere dead resistance connected into the circuit.

The tests covered the range from 80 volts up to 320 volts, and agreed very nicely with the law of the square.

Beyond 320 volts the dielectric medium apparently began to give way, and the energy-consumption increased faster than proportional to the square of the E. M. F. That was still more marked in a second set of observations, made right after the condenser was overstrained. Here the deviation from the law of squares began even at a lower E. M. F., and the energy-consumption increased so rapidly with increasing E. M. F., that the tests had to be interrupted.

In a third set of tests, on the next day, the dielectric had somewhat recovered; the energy-consumption remained proportional to the square of the E. M. F. up to about 250 volts, then increased more rapidly, and then suddenly increased very much, while the E. M. F went down, and a hissing noise was heard in the condenser; it had given way.

From the above we derive the conclusion, that up to an E. M. F., at which the dielectric begins to break down, the energy-consumption in the dielectric of a condenser is proportional to the square of the E. M. F. acting thereupon.

ECONOMY IN ARC LIGHT WIRING.

BY

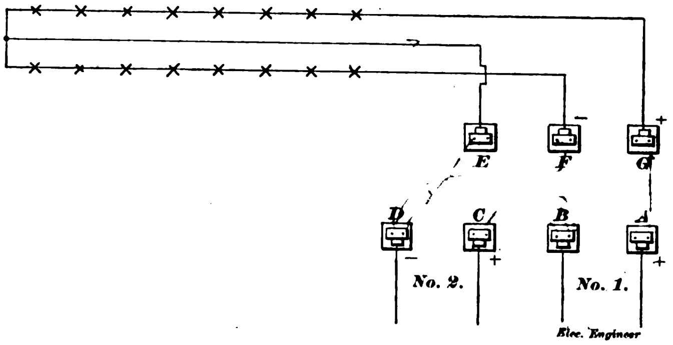
S. H. Sharpsteen

THERE are many towns throughout the country that have from 50 to 80 arc lamps and possibly many to be installed, of about the same number. Continuous service with a small amount of copper, with certain amount of loss of energy allowed, are important questions. If the town is long and scattered, copper will be a large item and must be used as economically as possible.

The first thing usually done is to put both municipal and commercial lamps on the same circuit, possibly with one large machine. The work is done in a hurry and the towns-people think with the stockholders and directors, possibly, that the plant shows much engineering skill. Fall comes with its long nights and the superintendent finds that he has got to burn his street lamps much longer, by far, than there is any need of. The final result is that another circuit has got to be run, the commercial lamps put on one, and the municipal lamps on the other.

About three years ago I adopted the following method and have found it to work well: By referring to the figure one can see that all the arc lamps were put on two legs of wire; the commercial lamps on one leg marked G and the municipal lamps on leg marked F. A third wire was started from a switchboard terminal E just to the left of the other two and run out on the pole-line until it came to the last commercial lamp and was there connected to the leg containing the commercial lamps.

The circuit went on some distance farther containing municipal lamps, but all that was necessary was to run past the last lamp of either leg. In the case referred to here there were two machines worked in series the switchboard terminals of one being C and D, and of the other A and B. Since the two were driven from the same countershaft with friction pulleys, when the commercial lamps were wanted, machine No. 1 was started and by means of the usual cables and plugs A and G were connected together; and also B and E; the result was that the commercial lamps were lighted.



PLAN OF CIRCUITS FOR ARC LIGHTING.

Later on when it was dark enough to want the street lamps, machine No. 2 was started, the brushes put down at point of minimum working capacity when by means of the remaining hole in the terminal B, the latter was connected with C; and by means of the remaining hole in E, E was connected with D. The result was that machine No. 2 was in circuit with no load and if brushes were not at the point above referred to they would burn. The next thing in order was to disconnect E and B, which put both machines on the commercial circuit. Now to get E out and F into circuit, one plug of the cable just taken off from the switchboard was put into the remaining hole at D. The other plug was put into the right hand and held near F until the plug in E was withdrawn far enough to draw a short arc, when the plug held in the right hand was put into one of the holes in F, when the arc at E let go and both lamp legs were on both machines. In this connection one might say, "Why not leave plug in E until plug is into F?" This would be all right if machines were automatic in regulation, but if not, the current would be apt to increase in quantity since there would be two paths for the returning current and resistance decreased. One good feature of having two machines is to make partly sure of always having the commercial circuit working. In case of an accident or some little thing occurring that causes the shutting down of one machine the other machine can be made to work the commercial lamps alone.

MR. TOMPKINS, superintendent of the Berkshire Electric Co., is spending the winter in California.

INSULATED ELECTRIC CONDUCTORS.[1]—I.

BY

James Bowstead Williams M.D.

Chapter I.

In San Francisco, in 1886, during a conversation with a friend relating to electrical matters, the question was asked, "Isn't it possible to invent *some* means by which the escape of the current from telegraph lines can be lessened, or even prevented?" The speaker then added: "When I was an operator in Arizona, we had a great deal of trouble with our railroad lines during certain seasons of the year, and at times could not communicate with cities in California." As my attention had never been directly called to this matter before, these remarks caused me to wonder whether or not something could be invented which would prevent the escape of the electric current from the line to the glass insulators; for my experience of glass as an insulator, in 1868—during which year I made a frictional machine, the cylinder of which was a large bay rum bottle—and some years later, while making and using Ruhmkorff coils, had taught me that glass could not always be depended upon to insulate electric currents, particularly high tension currents, on account of the deposition of moisture upon its surface during certain atmospheric conditions.

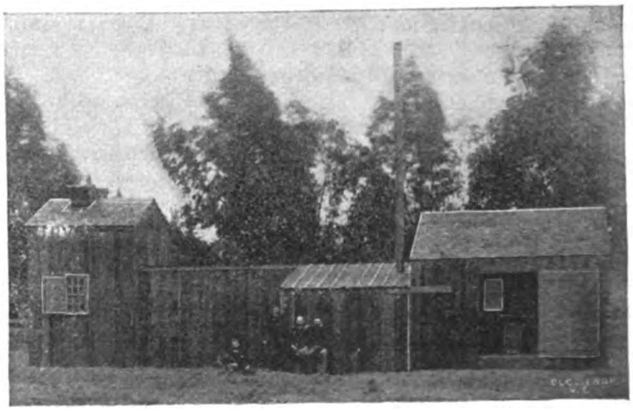
I considered this matter for several days, when the thought occurred to me, "Why not, instead of simply trying to discover a better way of insulating telegraph wires than by the use of the ordinary glass insulators, institute a thorough examination of all obtainable insulating materials and endeavor to produce compositions for the efficient insulation of *all* kinds of electric conductors?" And the longer I considered the matter, the more determined I was to begin the examination.

At that time it was generally supposed that "Underwriter's Wire"—since very appropriately called "Undertaker's Wire"—was good enough for all ordinary purposes; and remarks somewhat similar to the following were made to me by parties who were supposed to know something about insulation:—"Why hunt for anything better than underwriter's wire? For if it were *not* good enough why do you suppose underwriters would recommend its use?" "Its universal use is proof enough of the value placed upon it." "What we need the most is a wire which will not allow fire to run along its surface." I was not discouraged by such remarks, however, but began to devote all the time I could spare from my practice to the study of the subject of insulation; read all of the United States and English patents relating to the subject; consulted text-books, reports of English committees, and other literature in the libraries; and realizing the commercial value of highly insulated wires and cables, I decided to commence active work at once. But before commencing my investigation I readily saw that special testing apparatus would be required, in order to enable me to rapidly determine the comparative insulation resistances of *short* pieces of highly insulated wires. I therefore designed and made a modified form of Sir William Thomson's quadrant electrometer, with replenisher and gauge in a separate vessel, together with the necessary discharge key and other necessary adjuncts; and since then I have never regretted the time spent in making them. This testing outfit will be illustrated and described in a subsequent article.

After providing myself wiith these testing instruments, I obtained samples of all the insulated conductors I could procure, and insulating material of various kinds, and began the practical study of the insulation of electric conductors. My first "mixing rolls" consisted of a marble slab, heated over a coal oil stove, and a stout wooden spatula, with which I succeeded in mixing several rubber compounds. For compositions combined directly by means of heat, *i. e.*, while in a melted state, I used agate ware saucepans; and for those combined by means of solvents, double-chambered vessels and evaporating dishes. My first "tubing machine" I made of brass tubing, and provided it with a piston which was operated with a strong screw and handle, and the necessary dies with their centering and adjusting devices. By means of this tubing machine I was able to cover wires with compositions which were readily rendered plastic by heat. My first experiments in vulcanizing were performed with a dental vulcanizer.

One of the first pieces of wire which I insulated with a rubber compound I still have; and its insulating layer, although exposed to air, moisture, etc., for nearly five years, and mixed and applied in the crudest manner, still retains its insulating properties apparently unchanged.

Encouraged by my first efforts, and seeing the necessity of more fully investigating the subject, and also of having suitable machinery, I informed a former schoolmate and friend, Dr. James L. de Fremery, of my researches and work, who, after seeing the results I had already obtained, generously informed me that the necessary funds should not be lacking to make a most thorough examination of all obtainable insulating materials and methods of using them; and he has my sincere thanks for both his moral and financial backing. I then gave up my practice as a physician and visited Eastern cities, in April 1887, for the purpose of purchasing machinery, materials to experiment upon, insulated wires, and whatever else was necessary for the work. Immediatly after my return to California, the laboratory, a photograph of which is shown in the accompanying illustration, was built in Oakland, and equipped with the necessary machinery, a portion of which was obtained in the East, and the remainder either made in my workshop or by others after designs of my own. The atmosphere in and about the laboratory was continually charged with moisture and gases from marshes which lay between the laboratory and San Francisco Bay, and oftentimes with sewer gas. The trade winds, with their accompanying fogs, which often last from March until November, blew directly across the marshes from the Pacific; and nearly every night during a portion of the year the lower part of the building was enveloped in a thick mist. So great was the amount of moisture *always* present in the atmosphere that we were obliged to keep the machinery covered, except while in use, with a layer of thick petroleum, in order to prevent its rusting; and even the petroleum (18° B.) was not proof against the effects of the moisture and various gases, but had to be renewed every few days.



Laboratory for Testing Insulated Wires.

These facts are stated to show what severe conditions, purposely chosen, the insulating materials were subjected to during their examination and use; and it was owing to these conditions that we were often enabled to observe the effects of moisture, gases, etc., upon the different materials, simple and compound, in a few hours instead of having to wait for days or weeks, as would have been the case had the work been carried on under favorable conditions.

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Throughout the entire work in California, both in laboratory and factory, which occupied more than three years' time and at an expenditure of several thousand dollars, I was ably assisted by my brother, Mr. Rufus W. Welty, who was of the greatest service to me, particularly in the setting up and management of machinery, and in designing and making new forms of the same. Whenever the work was of such a nature that additional help was necessary, I employed from one to four others, as occasion required.

Having written this somewhat long introduction, the different kinds of material experimented upon will be enumerated, and a description of the various ways in which they were used and examined, and also of the electrical apparatus employed in testing the same, will be given; after which the writer will endeavor to set forth, in simple and concise language, and probably for the first time, how all kinds of insulated electric conductors can be manufactured for use, from the selection and preparation of the materials with which the metallic conductors are covered, to the finishing of the insulated conductors and protection of the same, including descriptions of the machinery used, and the processes employed, in their production; and to the above will be added, from time to time, as occasion requires, other items of importance relating to the subject of insulation which have been obtained from laboratory and factory practice. As all insulated conductors now in general use may conveniently be divided into types or classes, but one example of each type will generally be selected for illustration; and these types will be referred to as types 1, 2, 3, et seq., except the inexpensive types—such as magnet wire, weatherproof wire, etc., —which will be called by their proper names. In addition to the types above mentioned, illustrations and descriptions of some new forms of insulated conductors invented by the writer and secured by letters patent of the United States and foreign countries will be given.

It is evident to any one familiar with the manufacture of two or more types of insulated conductors that, in treating of a subject embracing the details of the manufacture, etc., of more than a dozen types, repetitions of such details are unavoidable; but, unless necessary to a proper understanding of the subject, they will be made as few in number as possible. The principal substances examined in laboratory and factory were india-rubber and gutta-percha; resins and gum resins, such as colophony, copal, amber, shellac, pitch, etc.; paraffines and paraffine oils; coal tar and its asphaltum; petroleum, asphaltum, and other petroleum products; vegetable oils, such as linseed, cotton seed, etc.; fibrous material, including paper, parchment, jute and cotton and silk; and several mineral substances, such as asbestos, silica and silicates, lead and zinc salts, lime, etc. These substances and many others were examined singly, whenever they could be so examined, and in suitable combinations (oftentimes unsuitable combinations) of two or more. The total number of combinations exceeded five hundred; and the methods of combining the substances, applying them to conductors and testing them, and the apparatus with which they were electrically tested, will now be described in the following chapters.

"DIE ELEKTRIZITAET."

A NEW semi-monthly periodical with this title, the organ of the Leipziger Elektrotechniker-Verein, has just made its appearance. There are a number of electrical societies springing up in Germany.

AN ELECTROLYTIC WATTMETER.

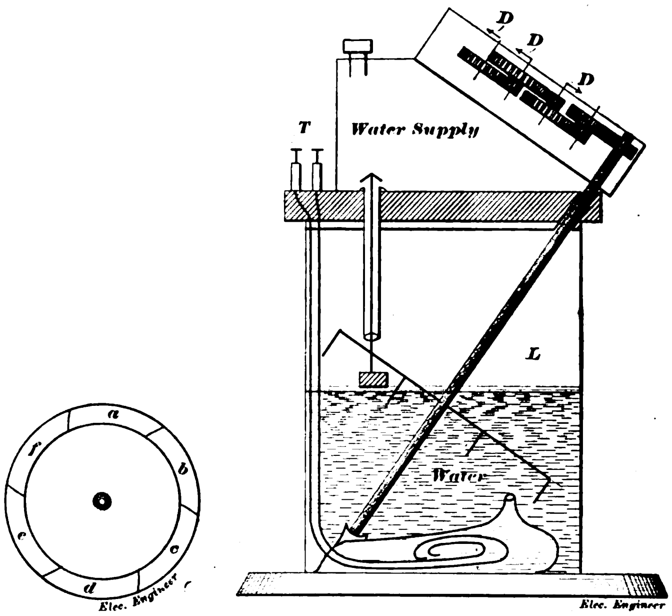
BY

F. A. LaRoche

PERHAPS no subject of inquiry has received more attention from the electrical mind than the production of a satisfactory wattmeter. Of the many valuable achievements in this direction it is safe to say, that not one embraces all the features of the ideal instrument. It is not claimed that the device here described even approaches the ideal; but one sterling virtue recommends it to notice. While on minor counts, it is quite possible to excel the instrument under discussion, yet in point of accuracy it stands eminently superior. Every little variation of current is noted and summed up in the final registration with unfailing fidelity.

For its action this meter depends upon the electrolysis of water. The principle is not new, but in the method of its application lies the originality and usefulness.

The whole mechanism is contained within a circular glass jar covered by a loosely fitted lid; this jar is about eight inches in length and six in diameter. Inside and upon the bottom of the jar is placed a circular receptacle; this addition is also of glass, and provided with a rim that raises it from the bottom of the jar leaving a hollow space one inch in height. Within this enclosure the terminal wires are placed, and the gases liberated. The top of this enclosure is slightly convex but rising higher near the circumference on one side, and terminating in a conical elevation. Through an aperture in this cone the gases escape to be measured and accounted for.



FIGS. 1 AND 2.—LA ROCHE ELECTROLYTIC WATTMETER.

The construction of the apparatus will be clearly understood by reference to the accompanying illustrations.

Fig. 1 represents a disc of vulcanite, the rim of which is divided into six equal compartments, *a*, *b*, *c*, *d*, *e*, *f*, that are raised upon one side of the disc. These divisions form cups about one inch in depth, and the same in width, each entirely separate and gas tight. Through the centre of the disc is secured a shaft consisting of a long, pointed glass rod upon which the whole is intended to revolve.

Fig. 2 represents a vertical section of the meter ready for use. In this figure will be observed the disc and rod in position, the cups opening toward the bottom of the jar, and the lower edge of the disc immediately over the cone from which escape the gases before mentioned. When the jar is filled to the level L, Fig. 2, with a mixture of sulphuric acid, one part, and 10 parts water, and the current passed through the terminals T, the following results ensue:

Water is decomposed into its elementary constituents oxygen and hydrogen. These gases collect in the top of the enclosure at the bottom of the jar from whence they escape through the opening at the apex of the cone C. The position of the disc is such that all of the escaping gases is collected within the inverted cups.

It will be observed that the disc is inclined at an angle of about 45 degrees. This is necessary to secure the desired end. As the gases fill the cups the upward pressure increases, causing the disc and shaft to gently rotate upon the point.

As each cupful of gas reaches the summit during the rotation and commences to descend upon the other side, the gases escape and the cups again fill with water. Thus the operation is repeated as long as the current passes. From the end of the inclined shaft the record is carried through a train of gear wheels to the several dials, D, Fig. 2, from which the readings are taken.

This apparatus is very simple in its construction but a number of precautions are necessary to insure its accuracy. The liquid must be kept at a constant level within the cell. This is accomplished by placing a reservoir over the top of the jar with a supply pipe that is closed automatically, when the liquid reaches the proper level.

The terminal connected to the positive wire should be made of platinum foil, otherwise the nascent oxygen would speedily destroy it. The negative, however, may be made of sheet lead, as hydrogen is liberated here and is not attended with any corrosive action.

There is but one possibility of a perverted record with this instrument and that would be brought about by the expansion of the gases, provided the temperature should rise unusually, but even here the discrepancy is more theoretical than real. When we remember that gases expand but $\frac{1}{492}$ of their bulk for a rise in temperature of one degree, the consideration becomes insignificant as practical demonstration has proven.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—VII.

BY

Francis B. Crocker and S. S. Wheeler.

CHAPTER IV.—*Continued.*

Constant Current Motor.—The commonest example is a series wound motor on the arc circuit. The connections are shown in Fig. 19. The switch 1 is to entirely disconnect the circuit from the building in case of fire or other emergency. By simply turning the other switch 2 the motor is started or stopped, and since the current is constant the motor may be overloaded or held still without injury, whereas a constant potential motor would burn out. The precaution necessary is never to touch the machine with current on, as the E. M. F. is probably high and very dangerous. Turn off the switch to fix the machine. A constant current motor should be provided with an effective centrifugal governor for controlling the speed, otherwise it will run away when the load is taken off, like a series motor on a constant potential circuit.

Alternating Current Motors.—These have not been very extensively used up to the present time, although a great variety of forms have been tried or suggested. Alternating motors are required to run on constant potential circuits since almost all alternating current systems are of this kind. But with alternating current there is no trouble from the rush of current which tends to occur in starting a motor with a constant potential direct current, because the self-induction of the field and armature coils prevents it. There are several types of alternating current motors. The simplest of these is a plain series or shunt machine the same as for direct current, except that the field magnet is laminated as well as the armature. The trouble with this type, which has been used commercially in small sizes, is that bad sparking is apt to occur when the brush passes from one commutator bar to the next and short circuits a coil which has alternating currents generated in it by the reversals of the field magnetism. An ordinary alternating current dynamo can be used as a motor but its speed must be brought to agree with the current alternations before it will run, and then if it loses this exact speed it stops, and is therefore unpractical. In the Tesla and other similar motors the effect is obtained by a rotary current, but this requires two or more currents of different phase and usually a special three-wire system would have to be put in before such motors could be operated.

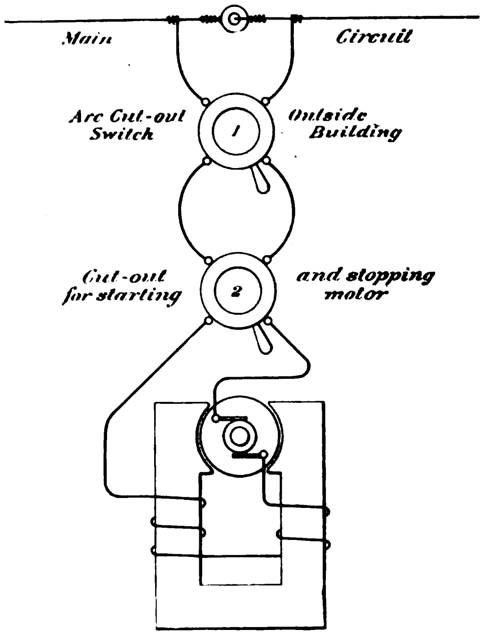


FIG. 19.—SERIES MOTOR ON CONSTANT CURRENT CIRCUIT.

CHAPTER V.

DIRECTIONS FOR RUNNING DYNAMOS AND MOTORS.

After one of these machines has been properly started as described in the previous chapter, it usually requires very little attention while running, in fact a dynamo or motor frequently runs well all day without any care whatever.

In the case of a machine which has not been run before or has been changed in any way, it is of course wise to watch it closely at first. It is also well to give the bearings of a new machine plenty of oil at first, but not enough to run on the armature, commutator or any part that would be injured by it, and to run the belt rather slack until the bearings and belt have gotten into easy working condition. If possible, a new machine should be run without load or with a light one for an hour or two, or several hours in the case of a large machine, and it is always very objectionable to start a new machine on full load.

This is true even if the machine has been fully tested by its manufacturer and is in perfect condition, because there may be some fault in setting it up or other circumstance which would cause trouble. All machinery requires some adjustment and care for a certain time to get it into smooth working order.

When this condition is reached the only attention required is to supply oil when needed, and see that the machine is not overloaded. The person in charge should always be ready and sure to detect any trouble such as sparking, the heating of any part of machine, noise, abnormally high or low speed, before any injury is caused and to overcome it by following the directions given in the chapter devoted to these troubles. Those directions should be pretty thoroughly committed to mind in order to facilitate the prompt detection and remedy of any trouble when it suddenly occurs as is apt to be the case. If possible the machine should be shut down instantly when any trouble or indication of one appears, in order to avoid injury and give time for examination.

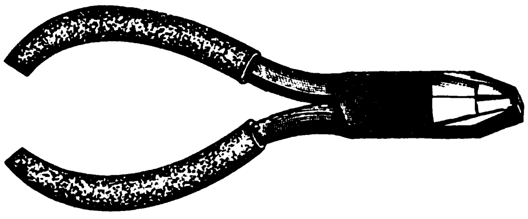


FIG. 20.—TOOL INSULATED WITH RUBBER TAPE OR TUBING.

Keep all tools or pieces of iron or steel away from the machine while running, as they might be drawn in by the magnetism and perhaps get between the armature and pole-pieces and ruin the machine. For this reason use a zinc, brass or copper oil-can instead of iron or "tin" (which latter is merely iron coated with tin).

Never lift a commutator brush while machine is running as it might make a bad burnt spot, unless there is one or more other brushes on the same side to carry the current.

Touch the bearings and field coils occasionally to see that they are not hot. To determine whether the armature is running hot, place the hand in the current of air thrown out from the armature by centrifugal force.

Personal Safety.—Never close a circuit through the body. An accidental contact may be made through the feet, hands, knees, or other part of body in some peculiar and unexpected manner. For example, men have been killed because they were sitting on a conducting body.

Rubber gloves or rubber shoes, or both, should be used in handling circuits over 500 volts. The safest plan is not to touch any conductor while the current is on, and it should be remembered that the current may be present when not expected, due to an accidental contact with some other wire or a change of connections. Tools with insulated handles or a dry stick of wood should be used instead of the bare hand.

The rule to use *only one hand* when handling dangerous electrical conductors or apparatus, is a very good one, because it avoids the chance, which is very great, of making contacts with both hands and getting the full current right through the body. This rule is often made still more definite by saying, "Keep one hand in the pocket" in order to make sure not to use it. The above precautions are often totally disregarded, particularly by those who have become careless by familiarity with dangerous currents. The result of this has been that *almost all the persons accidentally killed by electricity have been experienced electric linemen or station men.*

ELECTRICAL EXECUTION AT ABATTOIRS.

The Aberdeen abattoir is about to be lighted by electricity. In the event of the use in this direction of an alternating-current dynamo, a trial will be made of its capabilities for slaughtering cattle. It is anticipated that this application may become general if experience should prove that it has no detrimental effect upon the quality of the meat.

THE CAPACITY NECESSARY TO NEUTRALIZE A GIVEN SELF-INDUCTION.

BY

Norman Whichello.

MR. SWINBURNE'S recent paper, "The Probable Future of Condensers in Electric Lighting," having drawn attention to the use of condensers for supplying large "idle currents," or what I may term large "idle volts," instead of allowing the dynamo to do it, it has occurred to me that it might be well to show how to calculate the magnitude of the capacity required.

If we have a magnetic circuit to be energized we may do either of two things; (*a*), wind the magnetizing coils as for a continuous current of the same voltage as the alternator, and then place in series with them a condenser of such a capacity as to supply the P. D. necessary to drive the required current against the large impedance of the coil, Fig. 2; or (*b*), we may use a few turns of thick wire and shunt them by a condenser of such a capacity that the large idle current passing through the coils is supplied by the condenser instead of the dynamo.

It only remains to calculate the value of the capacity.

Case (*a*)

Let L = the self-induction (henrys).
r = the resistance (ohms).
k = the capacity (farads).

Let $C = C_0 \sin pt$ be the required current ($p = 2\pi$ times the frequency). Now if at any moment V be the P. D. between the coatings of the condenser and Q the charge on either coating, then $k = \frac{Q}{V}$.

$$\therefore \frac{dV}{dt} = \frac{1}{k} \cdot \frac{dQ}{dt} = \frac{1}{k} \cdot C$$

$$\therefore V = \frac{1}{k}\int C\,dt = \frac{1}{k}\,C_0\int \sin pt\,dt = -\frac{1}{kp}C_0 \cos pt.$$

And the P. D. required to drive the current against the self-induction is $L\frac{dc}{dt} = L \cdot \frac{d}{dt}\,C_0 \sin pt = L\,C_0 \cos pt.$ And against the resistance simply $r \cdot C_0 \cdot \sin pt.$ Hence the whole P. D. required is

$$V = C_0\left\{r \sin pt + \left(Lp - \frac{1}{kp}\right)\cos pt\right\},$$

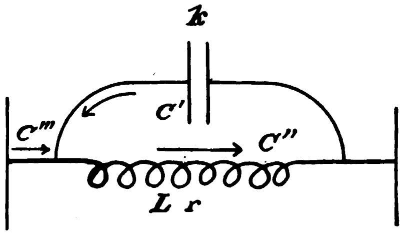


FIG. 1.

and this, by a well-known transformation, is

$$V = C_0\sqrt{r^2 + \left(Lp - \frac{1}{kp}\right)^2}\,\sin(pt + \varphi),$$

where φ is a lag angle; $\varphi = \tan^{-1}\left(\frac{Lp - \frac{1}{kp}}{r}\right)$.

Now if $Lp = \frac{1}{kp}$ *i. e.*, if $k = \frac{1}{Lp^2}$ the second term under the root vanishes and we have simply, $V = C_0 \cdot r \cdot \sin pt$

the same current which we should have if there were no self-induction and no capacity, in fact a current of the same effective value as on a continuous circuit of the same effective pressure.

The value which neutralizes the self-induction is then $k = \frac{1}{L p^2}$; curiously enough we shall find the same value for k in the parallel arrangement.

Notice that by increasing the frequency we can rapidly decrease k.

Case (b)

Let the volts on the mains be $V = V_0 \sin pt$, and use the same symbols as before; $k = \frac{Q}{V}$.

$$\therefore k \frac{dV}{dt} = \frac{dQ}{dt} = C'$$

$\therefore C' = k \frac{dV}{dt} = k \frac{d}{dt} (V_0 \sin pt) = V_0 k p \cos pt$, and the current through the inductive circuit is of course

$$C'' = \frac{V_0}{\sqrt{r^2 + L^2 p^2}} \sin (pt - \theta);$$

$$\theta = \tan^{-1} \frac{L p}{r}.$$

The current C' passes round the inductive coil and adds itself to the dynamo current C''', Fig. 1. Consider its sign carefully. Suppose for the moment that r were negligible; then both currents would be in quadrature with the E. M. F. on the mains, C' in front of the E. M. F., C'' behind it; consequently they would reach maxima simultaneously, C' flowing towards one main as shown by the arrow C'' away from that main as shown by its arrow; but C' passes through the inductive coil, and, as regards this local circuit round which C' flows, *these directions are the same.*

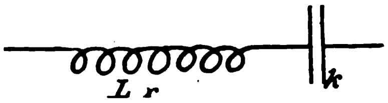


FIG. 2.

Hence we can find the value of C'' by changing the sign of C' and adding it to C'''.

$\therefore C''' - C' = C''$, hence C''' the dynamo current is

$$C''' = C'' + C'$$

$$= V_0 \left\{ \frac{1}{\sqrt{r^2 + L^2 p^2}} \sin (pt - \theta) + k p \cos pt \right\} \qquad (1)$$

And this may be reduced to

$$C''' = V_0 \sqrt{\frac{1 - 2 k L p^2}{r^2 + L^2 p^2} + k^2 p^2} \sin (pt + \psi) \qquad (2)$$

where ψ is a lag angle.

Now if $k = \frac{1}{L p^2}$ and $r = 0$, we have $C''' = 0$, so that the condenser would now be supplying the whole current (as we could have seen more easily in this special case, *i. e.*, when $r = 0$).

If $k = \frac{1}{L p^2}$ but r is not 0, then

$$C''' = V_0 \frac{r}{L p \sqrt{r^2 + L^2 p^2}} \sin (pt + \psi) \qquad (3)$$

But this is not quite the best value for k as we can see by differentiating the expression under the root in (2). If we do this we find that $k = \frac{L}{r^2 + L^2 p^2}$ makes C''' a minimum.

If $k = \frac{L}{r^2 + L^2 p^2}$

$$C''' = V_0 \frac{r}{r^2 + L^2 p^2} \sin (pt + \psi)$$

The amplitude of this current $V_0 \frac{r}{r^2 + L^2 p^2}$ is clearly somewhat smaller than that of the other $V_0 \frac{r}{L p \sqrt{r^2 + L^2 p^2}}$ and it is attained by the use of a smaller capacity. The difference however will be very slight in practice as $L p$ will be very much larger than r when iron is being magnetized.

Hence we may say that whether the condenser be arranged in series or in parallel with the inductance it should be equal to $\frac{1}{L p^2}$.

It might be well to point out that in consequence of alternators not giving true sign waves in practice and also in consequence of the fact that L is not constant when there is iron to be magnetized it will not be possible in practice to realize the above conclusions exactly.

That the capacities required are not usually inconveniently great the example below will show.

Let it be required to neutralize a self-induction of 5 henrys, the periodicity being 100 ~ per second.

$$\therefore L = 5 ; p = 2 \pi 100$$

$$k = \frac{1}{L p^2} = \frac{1}{5 \,.\, 4 \,.\, 10^4 \,.\, \pi^2} \text{ farads,}$$

$$= \frac{1}{2.10^6} \text{ farads (about)}$$

$$= 0.5 \text{ microfarad.}$$

THE DESIGNING OF DYNAMO ELECTRIC MACHINES.[1]

OSBORN P. LOOMIS.

DYNAMOS may be considered in two classes, namely, those used for supplying a variable current at a constant or nearly uniform pressure (such as those used in incandescent lighting) and those used in supplying a constant current at variable pressures depending on the resistance to be overcome in the external circuit. It might appear to some that the rules of design of a dynamo of one class ought to apply to the other, except in the matter of winding the frames, and it was at one time thought so even among electricians; but as investigation progressed it was found that not only were the requirements different, but different methods of designing were necessary to secure practical results.

The foundation stone of the dynamo-electric machine is magnetism, and in the incandescent machine this is particularly so. The days of slim and skinny dynamos for this work have gone by. The field magnets should be large and as short as compatible with the necessary wire to be wound upon them. The same holds true with regard to the pole-pieces, and I think that it is generally conceded among electricians that drum armatures are superior to the ring type for this class of work, except in the case of multipolar dynamos, which embody but another way of reducing the magnetic resistance of the core of the armature by multiplying the number of paths or circuits. With these conditions there is less distortion of the field magnetism upon changes of load put upon the armature.

Contrasted with machines for incandescent lighting, the design of a dynamo for running arc lights might be quite reversed. The frame should be quite light, and the pole-pieces should be thinned down, and in this case a ring armature is much to be preferred on account of electrical and magnetic reasons which will appear later.

The winding of dynamos is now generally divided into three classes or systems, as follows: 1. Series winding, in which all the current generated by the armature passes around the field magnets to the external circuit. 2. Shunt winding, in which only a part of the current passes around the field. 3. A mixture of the preceding called compound winding. This is a shunt wound dynamo, with the exception that all of the generated current passes around the field magnets a few times only, and assists the shunt magnetism for a regulative purpose.

This type is especially useful in generators for motor and incandescent work, and the object is to produce a constant pressure, and in some cases, to slightly increase it with increase of load to compensate for loss of potential in the line circuit to the point of consumption. These changes are instantly and automatically made in the dynamo itself without the aid of external appliances which are necessary in the use of a simple shunt wound dynamo. I might remark that in the early practice of compounding dynamos, this extra magnetic effect in some cases nearly equaled the shunt effect on acconnt of the high resistance of the armatures then built; but in recent dynamos this extra effect is comparatively small owing to the armatures being wound with few turns of wire.

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[1] A paper read before the Electrical Section of the Brooklyn Institute.

An additional advantage of the compounding is the strengthening of the field at the same instant the load comes on the armature, because at that time there is a tendency to distortion of the field magnetism, and still better effects result by placing the series or compound coils on the pole-pieces, or, as is sometimes done, over the whole armature. It might be argued that putting them anywhere on the magnetic circuit of the machine would do as well, as the magnetism must keep to the circuit; but in the large pole-pieces such as are commonly used, I think that the magnetic lines would be more easily pushed to one side if there were no winding on the pole-pieces. I will state that in my experience copper strip has given excellent results, the resistance being very low and the winding very compact.

What is known as series winding is principally used in dynamos for arc lighting to which it is admirably adapted. This class of generators has, until recently, been much misunderstood. It used to be thought that by shifting the brushes they were moved to points of higher or lower potential on the commutator, which is undoubtedly true, but is not all the truth; for, as the brushes are shifted, the magnetic or polar line is also shifted and this influences the field to a remarkable extent owing to the great number of turns on the armature which are necessary to produce the requisite pressure for this class of work. Together with this a comparatively weak field magnetism is used but is held above saturation by many wire turns in the field bobbins. In this condition of things the armature might be roughly termed a valve which allows more magnetism to pass through itself when the current is lessened (that is, by adding arc lamps) and tending to shut it off when the current is increased, as when lamps are cut out.

These effects are due, principally, to the peculiar construction of this armature running in a nearly constant field. These principles are taken advantage of by Mr. Stanley in his constant current alternating dynamo which automatically produces a uniform current from the capacity of the machine down to a short circuit. Of course, in a continuous current machine these actions are supplemented by an automatic regulator which shifts the brushes, and, as above stated, changes the polar line of the armature which intensifies these effects.

Attention is called to the stability of current in these dynamos. An arc light is a very unsteady resistance and it will be seen that if the field were responsive to these changes we would have anything but a constant current. This explains why it is necessary to put so little iron in the field magnets. Under these conditions they are above the saturation point and changes of the current in the field coils produce little change in magnetism. If this were not done there would be a periodic rise and fall of current and E. M. F.

In dynamos that produce a variable current with a constant or nearly uniform pressure at their terminals nearly the opposite course in design must be followed. The fields should be large and thick or be made multipolar, which is another and in many respects better, way of securing the same result. The magnetic effect of the armature should be made small by winding few turns of wire upon it. Electricians have been slowly but surely tending towards this point and, in proportion, better results have been realized. Another advantage secured in this design is the slight change in the non-sparking points on the commutator. This is due, of course, to a very weak armature running in a strong field, magnetically speaking.

Another extremely important point is that of diminishing the air gap by winding the armature with only one layer of wire. This reduces the resistance of the magnetic circut and renders it less liable to distortion under the varying currents delivered by the armature. If it were possible to find a suitable magnetizable substance which was at the same time a good conductor of electricity (say like copper) I think we could build what might be termed a commercially perfect dynamo (that is of this class); for with no air gap we could keep the polar line of the field perfectly steady. Consequently, what is termed the neutral or non-sparking points on the commutator would never shift and that trouble, known as sparking, over which electricians have heaved so many sighs, would be forever at an end. As this dream is certainly not realized at the present time, the next best thing we can do is to approach it as nearly as possible by reducing this air gap to its lowest limit. It is better to increase the circumference of the armature core in order to get the surface room than to put on the necessary turns in two layers, for the increased iron in the core is to the air space as 1 is to 20,000. Added to this is the advantage of a higher peripherial velocity of the armature wires.

If it is desired to secure extra fine results in special requirements it would be profitable to allow the surface of the poles to come down close to the conducting wire and bore slightly larger for the binding bands. It might not appear that the results would warrant the trouble, but it can easily be demonstrated.

In regard to armature cores I notice it has been the practice with some builders to carefully insulate the sheet iron discs from the shaft by a non-conducting sleeve. This certainly increases the magnetic resistance of the armature and in my experience I have found it wholly unnecessary. By slipping the discs upon the armature shaft directly I have not been able to discover any heating. It certainly saves trouble and at least ought to produce the same results.

Of late there has been some tendency to the use of laminated cores for field magnets. Apart from the better quality of iron, I cannot see any advantage in this practice, for the following reason: All lamination is used to break up circulating currents in the metal subject to magnetic changes, of which an armature is an excellent example; but with the exception of a dynamo using a toothed armature I think that it is generally understood that no magnetic changes occur in the field of a dynamo, or at least not with the frequency necessary for this precaution. In the case of a toothed armature I think a laminated pole-piece would be sufficient for all practical purposes, of course, referring to continuous current dynamos.

In practice I find good results by making the width of the pole piece equal to the diameter of the core. The following data of a machine embodying the principles just enumerated may be of interest.

Data of 16 Kilowatt Dynamo.

110 volts; 150 amperes; 1,400 revolutions.

Resistance of Armature	.022 ohm.
" " Series Coil	.005 "
" " Shunt Fields	20.00 ohms.
Area of cross section of each core	48.6 sq. in.
Area of cross section of pole-piece	107.5 sq. in.

60 turns on armature in one layer.
24 " " Series Coils.
4,088 " " Shunt Fields.

Cross section of wire on armature	25,998 sq. mils.
" " " Copper strip on series	138,000 " "
" " " Wire on shunt fields	5,128 " "

There are some few practical points in regard to commutators and brushes worth mentioning. A brush should bear with a firm elastic pressure on the surface of the commutator. If the spring is not stiff enough, any little unevenness on the commutator will cause the brush to jump from the surface and then trouble commences and grows worse instead of better. By using a firm spring the brush will be held to the surface regardless of slight projections. Again, the brush-holders should be free to slide laterally on the studs to allow the brushes to be placed on the surface of the commutator so as to break joints, thus keeping it free from ridges.

When the commutator pits out at one segment repeatedly a defective joint will generally be found at the junction of the wires and bar. The explanation is that as the brush leaves a good connection and strikes a poorer one a spark is formed repeatedly and gradually eats it away.

It might be thought that the electrical part of the dynamo was all that was worth talking about, but I might mention a little incident. While conversing with a mechanical engineer of considerable experience he remarked that electricians had to learn mechanical experience all over again in the matter of journals, which had not been made long enough in the past. They should be made large, not because a larger bearing in itself runs cooler, but because large shafts do not spring out of line while running.

Turning toward the subject of lubrication there are several forms of self oiling journals in use and they generally give satisfaction, being automatic and much cleaner in their operation. A form recently designed consists of a woven chain ribbon running over, or carried by, a serrated surface on the shaft. I think that this may have some advantages over the ring, as it seems to gather up more oil. There are many that think the old oil cups are good enough but I am sure a little experience with a self oiling machine would secure their preference.

SUBSIDY FOR A CABLE TO JAPAN.

It is officially announced at Ottawa, Can. that the Canadian Pacific Railway has received positive assurances that the Imperial Government will grant a subsidy toward the construction of a new submarine cable between British Columbia and Japan. President Shaughnessy of the railroad, who has just arrived from Yokohama, says that arrangements have been made with the Mikado's Government for the use of land lines in Japan. Efforts are now being made among English capitalists to raise the money and float a company to undertake the construction and operation of the proposed cable in conjunction with the Commercial Cable and the Canadian Pacific route, as already chosen. This route presents very few obstacles and is certainly much better than the Southern Pacific route.

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VOL. XIII. NEW YORK, MARCH 16, 1892. NO. 202.

There is nothing superfluous, or deficient, or accidental, or indifferent in Nature.—Faraday.

SIEMENS & HALSKE IN AMERICA.

ALLUSION has already been made more than once in THE ELECTRICAL ENGINEER to the reported intention of Siemens & Halske, the great electrical manufacturers of Europe, to establish a branch or semi-independent factory in this country—thus taking a leaf out of the book of the Western Electric Co., who have rooted themselves firmly in Europe, and whose success there is an old story. It is now stated that Siemens & Halske will build their American works at once, taking Chicago as a location, and that they will impress the public with their presence and importance by making a very fine display at the World's Fair next year.

In some quarters there is a disposition to be incredulous with regard to this rumored new departure, but we have good reason to assert that large plans will soon be carried into effect. It might, perhaps, be thought that the plan is a counterclap to the movements recently made by the Thomson-Houston Company in Germany. There, as we mentioned about a month ago, the Union Electric Company has just been organized in Berlin, consisting of Loewe & Co., Thyssen & Co., Mulheim-on-the-Rhine, and the Thomson-Houston International Electric Company of Boston. The new concern has acquired all the patent rights of the Thomson-Houston International Electric Company for Germany, Austria and Northern and Eastern Europe. The company, it is said, does not intend to erect its own factories, but will have its entire manufacturing done by Loewe & Co. The capital stock of the new company is 1,500,000 marks, equally distributed between the three contracting parties. The company will devote special attention to the introduction of Thomson-Houston apparatus, both for lighting and power purposes. Now, it might be argued that the proposition of Siemens & Halske to "carry the war" into America is intended to check or offset this invasion in heavier force of their own territory; but such seems to us a narrow view of the situation.

Siemens & Halske will not be the first manufacturers to migrate from Europe to this country nor will they be the last. As we said a few weeks ago, the fact that even two such strong concerns as the Edison and Thomson-Houston companies have joined hands does not by any means prove that the field is closed up for others who would exploit the numerous opportunities of electrical work. While the new American combination controls many extremely valuable patents, some of them exclusive, it is far from monopolizing all the electrical inventions of the age in light, heat and power; and with the increasing activity in every department, the likelihood of such a concentration grows less possible every month, especially as the lapse of time must throw open to the public that which now enjoys rightly the protection of the law. There comes a point, too, in every great industry, even the simplest, at which it ceases to be desirable or feasible to invest any body of men with more and more power, simply because executive ability is limited by harsh conditions of time, strength, and distance. With respect to the Siemens & Halske Company, it may be pointed out that they are genuine pioneers in light and power, and that they thus have also a number of formidable patents, as well as a fund of experience that would be hard to beat.

It is understood, we have said, that the Siemens & Halske works will be established at Chicago, though there is a possibility that the concern may build a town of its own, if it intends to employ the 4,000 men with whom rumor credits it. We can only say that the American electrical public will be glad to see this enterprise started, and that while no one expects to learn much from its European methods, the indirect good to the electrical industries of the country by this accession of skill and capital must be enormous.

ELECTRICITY FOR MASSACHUSETTS STEAM ROADS.

THE late James T. Furber, general manager of the Boston and Maine Railroad system, was a believer in the near substitution of electricity for steam on many of the shorter railroads of New England, and he appears to have found other railway men who agreed with him, notably President Choate, of the Old Colony Road. Be this as it may, the ripening of conviction is seen in the fact that the Railroad Committee of the Massachusetts Legislature has unanimously reported a bill to permit change from the one motive power to the other. The bill provides that "Railroad Corporations which are subject to the provisions of chapter 112 of the Public Statutes and amendments thereto are hereby authorized to operate their railroads by electricity." The chapter referred to is the railroad law of the it is not surprising to see her prompt to try a motive State. It will be remembered that Massachusetts began very early in the matter of adopting steam locomotion, and power that has already given so much satisfaction in the heaviest street railway work. Meantime, the Pennsylvania Railroad Company is beginning its Newark road across the Jersey marshes, and Mr. Villard is studying out the problem for Chicago. May we not hope that the New York Central will soon give us such a service for the Tunnel, from 125th street to the 42d street depot?

THE LAW OF DIELECTRIC HYSTERESIS.

The investigations carried on by Mr. Charles P. Steinmetz on the nature of hysteresis in iron and other magnetic metals have already resulted in the enunciation of a most important law, which cannot fail to be of the greatest service to the constructor of dynamo-electric machinery and electro-magnetic apparatus in general. But those who have followed the course of events, especially in modern alternate current work, cannot fail to have recognized the increasing importance and application of the condenser as an auxiliary apparatus employed to obtain the necessary phase difference. Mr. Steinmetz has now enunciated the corresponding law for the electrostatic cycles in dielectrics, and it is interesting to note that while in the case of iron the magnetic hysteresis varies as the 1.6th power of the magnetization, the electrostatic hysteresis follows the simple law of squares. Exact determinations of electrostatic phenomena are far more scarce than were those of magnetic hysteresis before the publication of Mr. Steinmetz's recent paper, and probably because the difficulties accompanying such determination are greater than in the case of magnetic hysteresis. That electrostatic hysteresis will have to be taken into account in large modern power alternate current transmissions is evident from the results obtained at Frankfort. Where the capacity of the lines is necessarily large, a very large charging current is present and the loss of energy by dielectric hysteresis may have a large influence on the efficiency of transmission. The direct bearing of the law enunciated by Mr. Steinmetz in such cases must be at once apparent, and it is to be hoped that he will continue his researches in this branch.

COST OF LONG-DISTANCE TRANSMISSION.

Much has been said and written recently on long-distance power transmission by electricity, but as President Huntley pointed out in his address before the National Electric Light Association, at Buffalo, the one question above all which cannot be lost sight of is, Will it pay? For, however promising schemes of this sort may appear, and however willing and able the engineer may be to carry out the work, the investor never loses sight of the fact that a fair return for the capital outlay must be reasonably assured. We also showed in this column in our last issue how easily one might be misled into the belief that a water-power, apparently abundant, might be transmitted to a distance, when a close analysis of the conditions involved would soon bring out the contrary fact. In discussing this subject in a recent address before the Chicago Electric Club, Dr. Louis Bell, after describing the various methods which the electrical engineer has available for this work in the different kinds of apparatus and types of motors, lays special stress upon the cost of such transmission. Taking as an example, to begin with, a case of direct current supply, he places the cost of generators at $30 per horse power. To this must be added, of course, the cost both of the copper wire and the pole line, and it is the latter which is too often lost sight of in the calculation. As Dr. Bell shows, the cost of the poles would vary very little, if any, with the potential employed, and hence with the amount of copper required; and, allowing 45 poles to the mile, the poles alone would cost $250 a mile, so that for long-distances the total expenditure would run up quite rapidly. If a motor generator be employed, there is the cost of three machines, costing, probably, $90 per horse power, initially. This would allow the use of high potentials and of a considerable saving in copper, and possibly, of somewhat lighter poles. The gain to be derived by the use of step-up transformers Dr. Bell showed depends very much upon the distance to be traversed, for it may happen that the cost of copper per kilowatt transmitted is less than $30, the cost of the transformers, and the distance to which one would be able to go before it would pay to step up, would thus be a considerable number of miles. Dr. Bell believes, in substance, that up to distances of 25 or 30 miles any one of the well-known methods now proposed are fitted to answer the purpose, but that to handle extremely long-distance work, still requires time and study.

ECONOMY IN ARC LIGHT WIRING.

The difficulties experienced in incandescent lighting at long distances, owing to the large amount of copper required, early led to the devising of the three-wire and other systems for effecting economy in this respect, and later on, to the alternating system. But while all these improvements have been going on in incandescent lighting work, few persons seem to have bestowed any attention on arc light circuits, which involve a by no means small outlay of capital, especially in our larger cities. Those engaged in the distribution of arc lighting for commercial and street lighting purposes will, therefore, be interested in the method described elsewhere by Mr. S. H. Sharpsteen for effecting a reduction in the amount of copper used, as well as in the number of circuits running out from a station. The method employed by Mr. Sharpsteen is quite analogous to that used at the Amoskeag Mills, at Manchester, N. H., as far back as 1881–82, and which has been cited as an assumable anticipation of the Edison three-wire system. In that case, however, the object sought for was to avoid a total extinguishing of the light in case one of the circuits broke down, while Mr. Sharpsteen, in addition, employs the method to effect quite a different object.

GOVERNMENT TELEGRAPHS AND TELEPHONES.

It would perhaps have been well if some of the active and high spirited business men of this country who are advocating control by the Government of the telegraphs and telephones could have been in Berlin during the recent riots. They would have found that the moment they made the slightest allusion to the riots, while using the telephone, the circuit was cut off, no matter how innocent the remark or how important the business under discussion. If American merchants and professional men want this kind of espionage and arbitrary interference, they deserve no better treatment. Moreover, the control of the telegraph lines was not less severe and rigid.

ON THE LAW OF HYSTERESIS.—VI.

BY CHARLES PROTEUS STEINMETZ.

1. The hardened steel curve, of high coercive force, has the bend or "knee" on the *negative* side, so that for zero M. M. F. the "remanent" magnetism is still in the saturation part of the curve —that is, in stable equilibrium; therefore permanently magnetizable.

2. The soft iron curve, with the bend on the *positive* side, so that for zero M. M. F. the "remanent" magnetism, though still very high, is already below the range of saturation, on the branch of unstable equilibrium. Therefore the remanent magnetism is very unstable and easily destroyed, the more as the coercitive force is very small.

3. The cast-iron curve, which has no marked knee at all, but a steady curvature of low remanent magnetization, but with regard to coercitive force ranging between 1 and 2.

The curve of the magnetic iron ore shows all the characteristics of a cast-iron curve.

Having derived, now, a larger number of values of the hysteretic coefficient η for different kinds of iron and other material, we shall put them together for comparison in Table XII.

For convenience, in the accompanying table are given the values W of consumption of energy in watts per cubic inch, for 100 complete periods (magnetic cycles) per second, and for the magnetization of H lines of force per square inch, giving as coefficient of hysteresis the value $\gamma = 8.3 \times 10^{-6}\ \eta$.

TABLE XII.

$$W = \gamma\ H^{1.6}$$

W in watts per cubic inch and 100 complete periods per second.

H in lines of magnetic force per square inch.

	γ	$H =$	10,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000	110,000	120,000	150,000
Very soft iron wire (Ewing)............	166 $\times 10^{-10}$	$W =$	.042	.13	24	.38	.55	.73	.94	1.16	1.40	1.66	1.94	2.28	3.18
Westinghouse converter, sheet-iron..	201		.051	.15	.29	.46	.66	.89	1.14	1.41	1.70	2.01	2.34	2.69	3.84
Very thin sheet-iron....	249		.063	.19	.36	.58	.82	1.10	1.41	1.74	2.11	2.49	2.90	3.34	4.77
Thick sheet-iron........................	277		.070	.21	.40	.64	.91	1.22	1.56	1.94	2.34	2.77	3.22	3.71	5.30
Sheet-iron	350		.089	.27	.50	.81	1.15	1.55	1.98	2.45	2.96	3.50	4.07	4.69	6.69
Sheet-iron	374		.095	.29	.54	.87	1.23	1.66	2.12	2.62	3.17	3.75	4.36	5.02	7.17
Soft annealed cast-steel................	663		.17	.51	.97	1.56	2.19	2.93	3.75	4.64	5.60	6.63	7.73	8.88	12.7
Machine steel, soft..........	778		.20	59	1.14	1.80	2.57	3.44	4.40	5.45	6.57	7.78	9.06	10.4	14.9
Cast-steel of low susceptibility........	994		.25	.76	1.45	2.30	3.28	4.39	5.62	6.95	8.39	9.94	11.6	13.3	19.0
Cast-iron	1846		.34	1.02	1.96	3.11	4.44	5.94	7.60	9.41	10.9	13.4	15.7	17.6	25.8
Hardened cast-steel	2077		.52	1.58	3.03	4.80	6.85	9.18	11.7	14.6	17 5	20.7	24.2	27.8	39.8

H — 25,0000 : alternate current transformer, American style (high frequency).

H — 35,000 ; " " " European " low "

Only the values smaller than .25 W, can be of practical use; in those larger than 10 the iron gets at least red hot if in larger quantities.

In the foregoing I have given a number of experimental values of the consumption of energy by hysteresis and believe to have shown that this consumption of energy can fairly well be expressed by the empirical formula, $H = \eta\ B^x$ where the exponent x is equal, or at least very nearly, to 1.6, and the coefficient η a constant of the material, which ranges from .002 to .025 and more, and may possibly have a slight dependence upon the *velocity* wherewith the magnetic cycle is performed, as the second set of alternate-current readings seems to indicate.

In the following Table XIII, I give the values of the hysteretic resistance η for some iron samples, subjected to a magnetic cycle between $F = + 190$ and $- 190$ ampere turns per centimetre, calculated from Hopkinson's tests[1] by the assumption of the law of hysteresis: η denotes the coefficient hysteresis; B the maximum magnetization in lines of magnetic force per square centimetre; R the remanent magnetization in lines of magnetic force per square centimetre.

TABLE XIII.

Material.	Condition.	η	B	R
Wrought-iron....	Annealed.	.00202	18,250	7,250
Soft Bessemer steel..........	.0 45 per cent. C. annealed	.00262	18,200	7,860
Soft Whitworth steel.*.	.09 " " "	.00257	19,840	7,080
	.32 " " "	.00598	18,740	9,840
	.89 " " "	.00786	16,120	10,740
	.32 " " oil-hard.	.00954	18,800	11,040
	.89 " " "	.01844	16,120	8,740
Silicon steel.....	3.44 " Si., wrought	.00967	15,150	11,070
	3.44 " " annealed	.00784	14,700	8,150
	3.44 " " oil-hard	.01282	14,700	8,080
Manganese steel..	4.73 " Mn., wrought	.05963	4,620	220
	8.74 " " "	......	747	......
	12.36 " " "	......	310	......
	4.78 " " annealed	.04146	10,580	5,850
	8.74 " " "	.08184	1,985	540
	4.73 " " oil-hard.	.06706	4,770	2,160
	8.74 " " "	......	783	......
Chrome-steel.. ..	.62 " Cr., wrought	.01179	15,780	9,320
	1.2 " " "	.01851	14,680	7,570
	.62 " " annealed	.00897	14,850	7,570
	1.2 " " "	.01638	13,230	6,490
	.62 " " oil-hard.	.03958	13,960	8,600
	1.2 " " "	.04442	12,870	7,890
Tungsten steel...	4.65 " Wo., wrought	.01516	15,720	10,140
	4 65 " " annealed	.01435	16,500	11,010
	3.44 " " oil-hard.	.04776	14,480	8,640
	2 35 " " very hard	.05778	12,130	6,820
Grey cast-iron...	3.45 p. c. C.; 17 p. c. Mn.	.01826	9,150	3,160
White cast-iron...	2.04 " C.; 84 " "	.01616	9,340	5,550
" " . .	4.5 " C.; 8.0 " "	......	385	77

These values of the hysteretic coefficient vary from .002 up to .082, 41 times the first value.

But especially noteworthy is the fact that η depends much less upon the chemical constitution of the iron sample, than upon its physical condition, *annealing decreasing*, and *hardening increasing* the hysteresis very considerably. So far as the chemical constitution is concerned, the purer the iron the lower is its hysteresis, while any kind of foreign matter increases the hysteresis. Especially manganese increases the hysteretic loss enormously, much less tungsten and chromium, least silicon and carbon. Connected with the increase of hysteresis is always a decrease in susceptibility.

I wish to add a few remarks on two alleged phenomena connected with hysteresis, which have been talked about considerably, without yet being made clear; the decrease of hysteresis for open magnetic circuit, and the decrease of hysteresis of a transformer with increasing load. With regard to the first, as shown, actual tests do not show a smaller value of hysteresis for open than for closed magnetic circuit. And it cannot be understood how that could be. For consider an iron molecule of the magnetic circuit exposed to the harmonically varying M. M. F. and performing a magnetic cycle. Evidently it can make no difference for this iron molecule, whether some trillion molecules further away, the magnetic circuit ends in air, or is closed entirely in iron, supposed that the M. M. F. and the magnetism, and therefore also the magnetic reluctance, are the same in both cases. Neither can it make any difference whether the M. M. F. is caused only by one sine-wave of electric current, or is the resultant of several M. M.

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[1] From "Kalender für Electrotechniker," by Uppenborn, Berlin, Germany.

F.'s, as in the loaded transformer. It is the same as with the electric current, where the energy converted into heat in each molecule of the conductor does not depend either, whether the material of the conductor on some other point changes, or whether one or more E. M. F.'s are acting upon the circuit. Hence, until absolutely exact and unquestioned determinations of the hysteretic loss for fully loaded transformers are at hand, the assumption of a decrease of hysteresis with increasing load must be rejected.[1]

That an apparent decrease with increasing load has been observed several times may be conceded, for besides the exceedingly great liability to errors in these tests, where the hysteretic loss comes out as the small difference of two large values, primary energy and secondary energy, and therefore is very much affected by the slightest error in any one of the components, it must be understood that the main possible errors in the determinations on fully loaded transformers all point this way. Neglect of secondary self-induction, decrease of magnetization with increasing load, slowing down of the dynamo-alternator, etc., all cause an apparent decrease in the hysteretic loss for increasing load. At least in one set of tests, those made by Prof. Ryan, at Cornell University, on a small Westinghouse converter, I was able to show in my "Elementary Geometrical Theory of the Alternate Current Transformer"[2] that the observed decrease of the hysteretic loss disappears by reducing the different readings to the same magnetization and the same frequency.

That an electromagnet without keeper loses its magnetism quicker than a magnet with keeper, or a closed magnetized iron ring, is a phenomenon, which has nothing whatever to do with this loss of energy by hysteresis, but is merely due to the demagnetizing force of the remanent magnetism. For the remanent magnetism in an open magnetic circuit causes between its poles a certain difference of magnetic potential, which in the moment of breaking the electric circuit acts as demagnetizing M. M. F., and if the coercitive force is small, as in wrought iron or annealed steel, almost entirely destroys the remanent magnetism, while in an iron of large coercitive force it affects the permanent magnetism very little. In the closed magnetic circuit the remanent magnetism causes none or very little difference of magnetic potential, and therefore no destruction of the remanent magnetism by its own demagnetizing M. M. F. takes place. But with the hysteretic loss of energy this phenomenon has nothing to do.

To combine the results, what I believed to have proved is that loss of energy in iron caused by reversals of magnetism can be expressed by the analytical formula: $H = \eta B^{1.6} + \varepsilon N B^2$ where η is the coefficient of hysteresis, ε the coefficient of eddy currents, N the frequency of the alternations of magnetism, $\eta B^{1.6}$ the loss of energy by hysteresis proper, or by *molecular friction*, and $\varepsilon N. B^2$ the loss of energy by eddy currents, per magnetic cycle and per cm.[3] proportional to the frequency N.

TABLE XIV.

B	$B^{1.6}$	Increase per 100.	B	$B^{1.6}$	Increase per 100.	B	$B^{1.6}$	Increase per 100.
500	.0208	42	9,000	2.122	378	17,000	5.870	55
1000	.0631	85	9,500	2.313	380	17,500	6.148	56
1500	1206	115	10,000	2.511	400	18,000	6.434	57
2000	.1913	142	10,500	2.716	41	18,500	6.722	58
2500	.2732	164	11,000	2.925	42	19.000	7.017	59
3000	.3659	185	11,500	3.141	43	19,500	7.312	59
3500	.4684	205	12,000	3.363	44	20,000	7.613	60
4000	.5800	223	12,500	3.589	45	22,000	8.868	63
4500	.7000	240	13.000	3.821	46	24,000	10.193	66
5000	.8288	258	13.500	4.060	47	26.000	11.59	70
5500	.9662	275	14,000	4.303	48	28,000	13.05	73
6000	1.111	292	14,500	4.580	49	30,000	14.57	76
6500	1.261	308	15,000	4.807	50	35,000	18.65	82
7000	1.420	324	15,500	5.062	51	40,000	23.09	89
7500	1.583	339	16.000	5.429	53	45,000	27.87	96
8000	1.758	353	16,500	5.598	54	50,000	33.00	103
8500	1.936	366						

For convenience, I give in Table XIV., the values of the 1.6th power of the numbers, from 500 to 50,000 with the increase of $B^{1.6}$ for 100 lines of magnetic force.

Having had time in the last few days to consider more deeply the relations of this Law of Hysteresis to Ewing's theory of magnetism, I came to the conclusion that this Law of Hysteresis agrees very nicely with Ewing's theory, giving just the phenomena that this theory leads us to expect.

According to Ewing's theory, for very low M. M. F.'s forces too small to affect the chains of molecular magnets, which exist in the magnetizable body when not under magnetic strain, the magnetic cycle should be almost reversible, that is hysteresis very small or almost nil.

For medium M. M. F.'s, that is, M. M. F.'s large enough to break up the chains of molecular magnets, the magnetic cycle should be expected to become markedly irreversible, and the hysteresis, as function of the M. M. F. must rapidly increase.

For high M. M. F.'s, where the chains of molecular magnets are already for the most part broken, the hysteretic loss, as function of the M. M. F. should increase more and more slowly.

This is exactly the case if the hysteresis follows the law of the 1.6th power of the magnetization.

This is not directly plain, because the law of 1.6th power gives the dependence of the hysteresis upon the *magnetization* while, to compare it with Ewing's theory, we have to produce the hysteresis as function of the M. M. F.

This is done in the diagram given in Fig. 5.

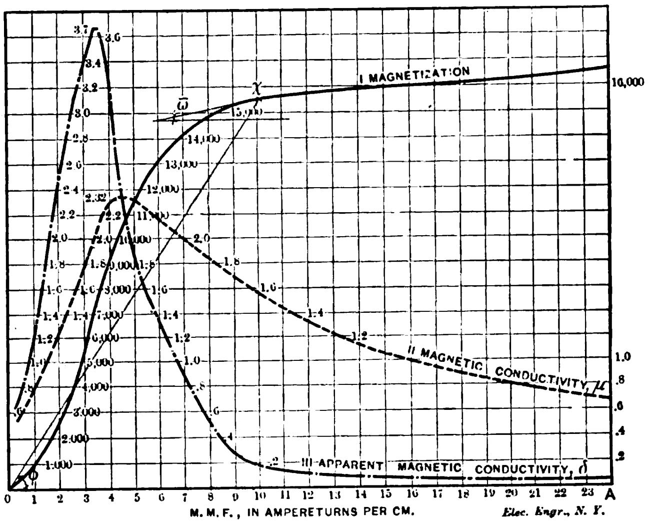

FIG. 5.

Here the *dotted curve* gives the magnetization B, in lines of magnetic force per $cm.^2$ as function of the M. M. F. F as abscissæ

In the *drawn curve* are given the losses by hysteresis, in ergs per cycle and $cm.^3$, calculated by the law of hysteresis: $H = .003507\ B^{1.6}$ but plotted not as function of the magnetization B, but as function of the M. M. F. F also: $H = f(F)$.

As seen from the plotted curve of hysteresis,[1] the hysteretic loss for low M. M. F.'s, $F = 0 \sim 1$, is very small and almost nil, then rises very rapidly for medium M. M. F.'s: $F = 2 \sim 5$, and then, for high M. M. F.'s, rises more and more slowly, just as Ewing's theory leads us to expect.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 8, 1892.

Alarms and Signals:—

Fire-Alarm and Telephone Apparatus, E. H. Amet, 470,231. Filed July 26, 1890.

The combination of a telephone system with an automatic fire-alarm.

Automatic Heat-Signaling Device, W. G. Day, 470,478. Filed March 18, 1891.

An automatic call box which will serve as a messenger call, a thermostat or a hand-operated fire signal.

Conductors, Conduits and Insulators:—

Conduit for Electric Wires, C. A. Freeman, 470,237. Filed Sept. 25, 1891.

Consists of a series of tubular sectional tiles fitted together by means of tongues and grooves which lock the sections against lateral and vertical displacement.

Underground Cables for Electric Cables, C. A. W. Hultman, 470,329. Filed June 9, 1891.

An underground conduit strengthened by means of metallic bars held in exterior longitudinal grooves and secured by cement.

Insulator for Overhead Electric Railways, H. D. Winton, 476,356. Filed Oct. 22, 1891.

Consists of an insulated body portion having at its extremities projecting studs to receive interchangeable attaching pieces for clamping the trolley wire and securing the insulator to the supports.

Insulator for Trolley Wires, W. S. Andrews and H. P. Ball, 470,417. Filed Oct. 1, 1891.

Insulator body composed of wood having a spun metal cover.

Dynamos and Motors:—

Electric Motor or Dynamo-Electric Machine, H. H. Hosford, 470,194. Filed June 4, 1891.

Employs a fixed commutator composed of bars having an angular relation to the brushes and their holders.

Electric Motor or Generator, R. Kennedy, 470,199. Filed Sept. 24, 1890.

Employs a field magnet having two independent windings and two independent synchronously rotating commutators, connected respectively with the windings in combination with the generator transmitting to each of these commutators an independent alternating current of like periodicity but of dissimilar phase.

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[1] The latest of Ewing prove that, in a fully-loaded transformer the loss by hysteresis is *not* smaller than for open secondary circuit.

[2] THE ELECTRICAL ENGINEER," December, 1891.

[1] This curve of hysteresis corresponds to a set of determinations, not contained in the paper, because made afterwards. I chose just this particular set of tests, because it covered a larger range of magnetizations than any one contained in the paper.

Connection for Armature Conductors, G. Stephens, 470,217. Filed Nov. 18, 1891.

Consists of means for attaching commutator strip to the segments without the use of solder while insuring permanent and reliable connection.

Electric Generator, C. J. Van Depoele, 470,521. Filed May 18, 1887.

Relates to improvements in systems of generating electric currents of constant potential.

Galvanic and Thermo-Electric Batteries :—

Electric Battery, V. Riatti, 470,260. Filed June 9, 1891.

Consists of a vessel composed of a bad conductor of heat and electricity charged with liquid capable of conducting electricity and having an electrical conductor at the bottom and a heating and conducting body at the top of the liquid.

Galvanic Battery, J. H. Davis, 470,552. Filed April 24, 1891.

A light, flexible battery jar in which the liquid is kept in continuous circulation through the chemical excitant and in contact with the electrodes of the battery.

Heating :—

Electrically Heated Oven, J. V. Capek, 470,418. Filed March 24, 1891.

Electric Oven, J. V. Capek, 470,419. Filed Aug. 14, 1891.

Lamps and Appurtenances :—

Regulating Socket or Holder for Incandescent Electric Lamps, E. E. Ries and W. S. Horry, 470,402. Filed May 5, 1891.

A socket for alternating current incandescent lamps, by means of which the intensity of the light may be varied by setting up a variable counter-electromotive force opposing the flow of current to the lamp.

Incandescent Electric Lamp, A. C. Carey, 470,471. Filed Aug. 3, 1891.

Claim :

In an electric light lamp leading-in or circuit wires, an incandescent filament, and a joint therefor composed of a double tube in which the ends of the filament and leading-in or circuit wires are secured.

Electric Search Light, R. S. Dobbie, 470,688. Filed Apr. 16, 1891.

Consists of improved means of mounting the lamp in the projector and for controlling its several moving parts.

Measurement :—

Movable Coil for Electrical Measuring Instruments, E. Weston, 470,340. Filed Mar. 11, 1891.

Electrical Measuring Instrument, E. Weston, 470,341. Filed June 4, 1891.

An electrical measuring instrument employing a movable and a fixed coil of wire, a mechanical dash pot to check the movement of the movable coil and means of converting the axial movement of such coil into rotary movement of an index over a scale.

Electric-Current Meter, J. W. T. Olan, 470,441. Filed June 6, 1891.

Claim 1 follows:

Combination in an electric meter of a vessel containing a liquid, a balanced float in said vessel and movable therein, said float having the forward movement only while the meter is in use, means for disturbing the balance in accordance with the current measured so that the float will move, and a recording mechanism operated by said movement.

Metallurgical :—

Magnetic Ore Separator, C. T. Thompson and R. N. Sanders, 470,455. Filed Apr. 16, 1891.

Magnetic Ore Separator, C. T. Thompson and R. H. Sanders, 470,456. Filed Dec. 5, 1891.

Miscellaneous :—

Purification of Brine, C. G. Collins, 470,181. Filed May 2, 1891.

Consists in introducing an independent supply of oxygen into the brine and subjecting the latter to a current of electricity.

Electric Gas Lighting Burner, H. A. Pinkham, 470,256. Filed Sept. 25, 1891.

Electrical Attachment for Pianos, F. A. Feldkamp, 470,294. Filed Nov. 9, 1891.

Electrical Wire Stripper, A. Cuthbert, 470,318. Filed Oct. 6, 1891.

Push Button, C. H. Delano, 470,372. Filed June 2, 1891.

Has for its object the exclusion of dust.

Electric Store Service Apparatus, M. W. Hassan, 470,428. Filed Feb. 2, 1891.

Dice-Box, F. W. Mader, 470,498. Filed Oct. 9, 1891.

Lightning Conductor, H. Simpson, 470,514. Filed Sept. 9, 1891.

Machine for Heading Spokes, T. Hill, 470,566. Filed Nov. 22, 1890.

An electric machine for securing the spokes to the rims of wheels and pulleys.

Electric Circuit-Closer, G. W. Price, 470,596. Filed Nov. 18, 1889.

A circuit-closer for door pulls, etc., consisting of a coiled helical spring which completes the circuit when elongated and breaks it again upon being released.

Electric Dust-Collector, R. E. Wardhaugh, 470,608. Filed Oct. 2, 1889.

Railways and Appliances :—

Electric Railway, E. Thomson, 470,221. Filed Oct. 9, 1889.

Consists of a series of pivoted contacts normally out of electrical connection with the main line, each contact pivoted to swing in the direction of movement of the vehicle and make connection during the passage of such vehicle.

Electric Car-Brake, J. Redmond, 470,505. Filed Oct. 17, 1891.

A brake for railway cars electrically actuated.

Electric Locomotive, E. A. Sperry, 470,516. Filed June 11, 1891.

Claim 1 follows :

In a power gearing for electric cars an electric motor, a hollow armature shaft for said motor, a power-transmitting shaft within the armature shaft connected by gearing to the car axle, an elastic or cushion connection between the two shafts and a rigid frame for the motor, elastically supported from the truck frames, whereby the motor may be located between the axles and permitted to vibrate independently of such axles.

Electric Locomotive, S. P. Hollingsworth, 470,627. Filed Dec. 15, 1891.

Claim 1 follows :

In an electric locomotive the combination of a continuously-running motor, the vehicle wheels and axles, a clutch member connected to the wheels by flexible couplings, a clutch member connected to the motor, a liquid for connecting the two clutch members and mechanism for controlling the flow of the liquid.

Switches and Cut-Outs :—

Electric Cut-Out and Safety Device, C. R. Meston and A. W. Meston, 470,204. Filed Jan. 12, 1891.

A ceiling rosette for incandescent lamps.

Safety Cut Out, M. Kerstein, 470,382. Filed June 8, 1891.

Claim 1 follows :

A combination of an electric wire composed of sections and provided with slip joints to connect the sections, of supports for the said sectional wire, and springs connected at one end to one of the said supports and at the other end to one member of the said slip joints.

Telegraphs : -

Telegraph Relay, C. M. Dyer, 470,557. Filed Sept. 9, 1891.

Provides a nicely balanced armature held in proper adjustment without regard to the variations of the electric current.

Telephones and Apparatus:—

Telephone, W. A. West, 470,634. Filed Nov. 12, 1883.

A reinforcing device which may be placed at any intermediate point of the telephone circuit and used as a relay, and which may also be used as a receiver or transmitter as desired.

THE NEW STATION OF THE BROOKLINE GAS LIGHT CO.[1]

BY ROBERT AMORY, M. D.

From the experience in our electric light station in Brookline, we carefully considered a plan of construction in our new station which should provide commodious and convenient access in all its parts, and especially with a view to economical administration. We consulted expert engineers, and finally decided to employ as our adviser Mr. Fry, chief engineer of the United States Treasury Building, in Boston. The result of a study and careful consideration of the problem, with both Mr. Isbell and Mr. Fry, is the present building, devoted to the creation, evolution and distribution of electrical force and its conversion into light.

The building, which is entirely of one story in height, is arranged with a boiler-room for eight so-called 125 h. p. boilers, but which are fitted with Smith's patent settings and feed-water circulation so as to produce about one-sixth more horse power than is commonly obtained from boilers of that size.

The belt from the engine pulley operates on a shaft built upon a brick foundation seven feet in height on a concrete bed seven feet deep, the bottom layer of the concrete resting upon the cribbing of a plank and timber foundation upon the top of the piles. This masonry bedding has no connection with the walls of the building.

The main countershaft is provided with positive clutches, the unlocking of which allows its separation from the motive power of any one or two of the three engines, whose unit power is 100 h. p., 150 h. p., 250 h. p., or 500 h. p. ; total, 750 h. p.

Briefly, the new electric and power plant, when complete, consists of a steam generating capacity of 1,200 h. p., using eight horizontal tubular boilers. In the future, if higher pressure or more power is desired, this capacity can be increased by using some form of water tube generator to a limit of 1,800 h. p. at 140 lbs. pressure. At present, three new horizontal tubular boilers are in service. The power portion, when complete, will consist of two 500 h. p. engines, one 100 h. p. engine and one 150 h. p. engine. Of these, the two latter are now in use at the old station. The one 500 h. p. engine, which has been installed, is a twin compound engine, constructed by the Armington & Sims Engine Co., of Providence. The cylinders are 21 × 31 inches, with a stroke of 18 inches, and the speed will be from 200 to 225 revolutions per minute. The engine is piped in a manner devised by Chief Engineer Fry of the United States Treasury Service so that either cylinder can be used, if necessary, independently of the other, either at a high pressure or as a simple condensing engine ; the two ordinarily operating as a compound condensing engine. By this arrangement, scarcely any accident can wholly deprive us of at least one-half of our main source of power. The use of this engine and the application of a condenser to the larger of the two engines to be brought from the old station, will effect a large proportionate saving in fuel over our present consumption, probably, at least 10 per cent. The shafting erected provides for a capacity of eight 50-light arc dynamos and three 1,000-light incandescent dynamos, and may be readily extended so as to admit of an increase of 100 more arc lights and 2,000 more incandescents at a relatively small expense. The shaft is so arranged that any one of the engines can drive the whole line, an important safeguard against total breakdown. The use of the Evans system for driving the arc dynamos obviates the use of much belting and so reduces the floor space required that, combined with the type of engines and arrangement of the shafting, we have all our motive steam and electric apparatus, aggregating 1,250 h. p. in one room 60 × 105 feet without undue crowding ; a greater economy of room than is known in any electric plant in New England or elsewhere. The steam piping, including that which supplies the heating system and the gas works, is designed for a working pressure of 125 lbs., and is so arranged that any boiler may be cut out at any time without interfering with the others.

In short, the entire plant has been put up in accord with modern practice, and, compared with others, at a moderate expense, keeping always in view the necessity for a possible growth, and prepared for that growth by methods of improved design and construction.

The incandescent dynamos at present to be run on the alternating system receive their motion from the countershaft (described above) by belting back to their position on the middle brick pier situated between the engines and the shafting beds.

By means of a newly devised switchboard, we can throw any one or more of these dynamos upon one circuit without the danger of running them in multiple or parallel with each other.

Finally, there is no combustible material in any of this construction ; even the switchboard and roof being formed of iron and slate, the roof being built by the Boston Iron Bridge Works, of Boston. There was one obstacle to this form of construction which, at first, seemed difficult to avoid, viz., the condensation of water upon the inside of the iron trusses and purlins of the roof. We borrowed here a simple device in use on our iron and steel

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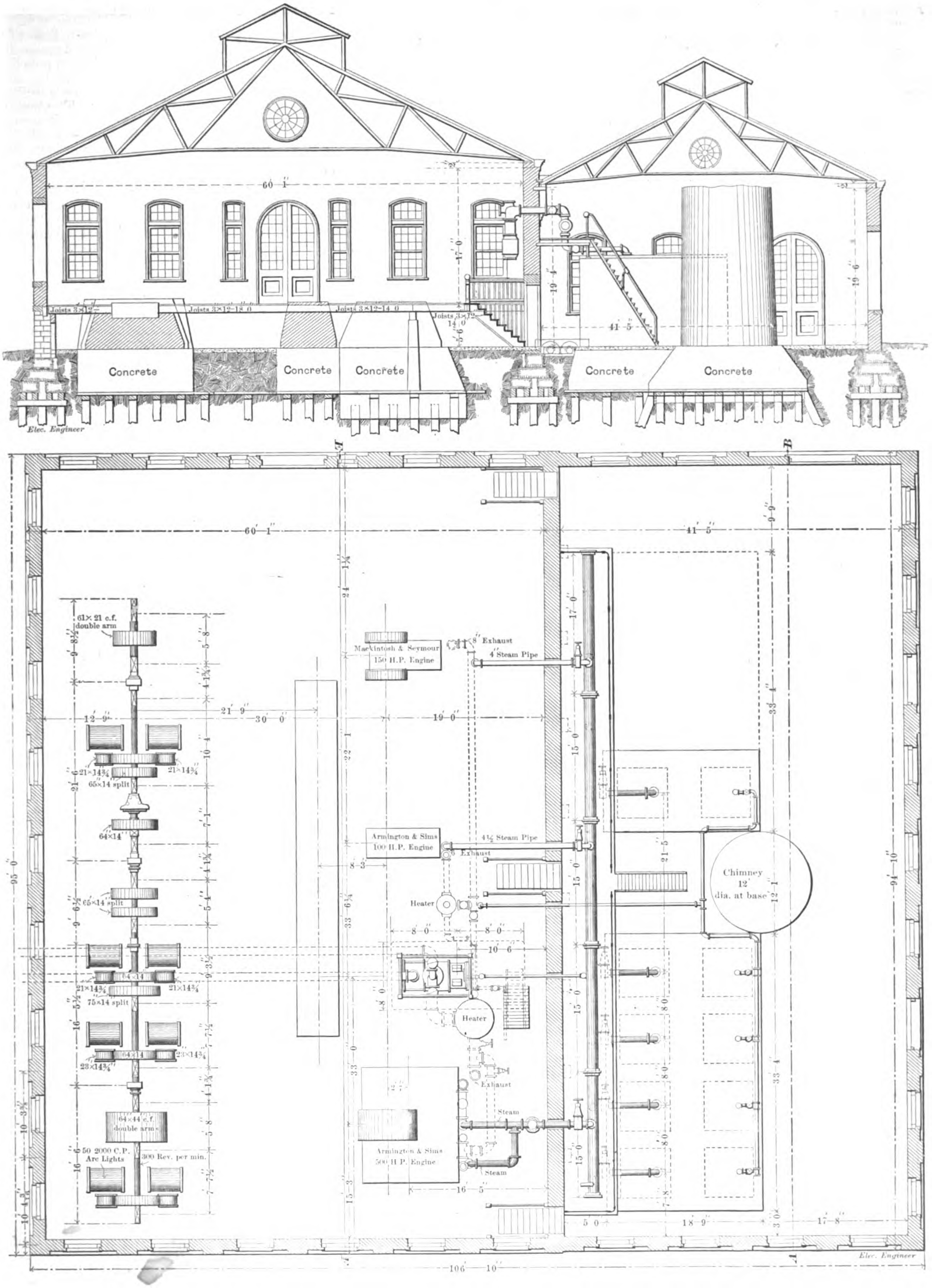
[1] Abstract of a paper read before the New England Association of Gas Engineers at their annual meeting, Feb. 18, 1892.



The New Electric Light Station of the Brookline, Mass., Gas Light Company—Plan and Section—(See page 284).

cruisers; we painted the inside of the iron and slate roof with ground cork and lead paint, which provides an air space around the metal and thus prevents the warm air from being condensed on the surfaces of the metal and slate.

The floor of the dynamo house is constructed of wood, which is entirely supported from the piling foundation, independent of the walls, and is the only combustible portion of the building. We thus save in insurance premiums annually $1,000.00 at the least estimate. We take out insurance policies only on coal house, office and stable buildings, and a very small amount on the purifier, condenser and meter houses, saving the premium on the value of about $200,000.

Personal.

COL. J. F. DILLONT, who has been business manager of *The Electrical World* for a little less than two years, has resigned, and will hereafter have no connection with that paper. During his stay in the electrical field, Col. Dillont has won a good many friends, all of whom will wish for him peace of mind and prosperity on the staff of the *Architectural and Building Monthly*, which he now joins.

A CORRECTION.

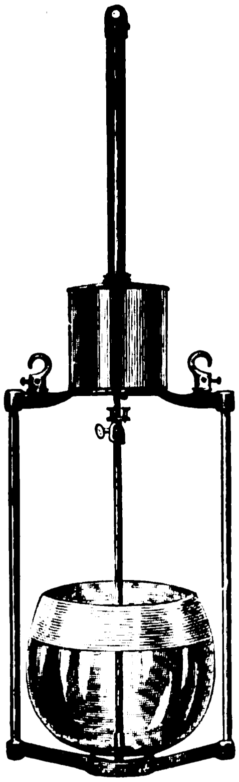
In our review of Trevert's "Armature and Field Magnet Winding," last week, it was erroneously stated that the price is 50 cents. It should be $1.50.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT

"Ads." are to business what feeders are to the trolley wires.

THE DUPLEX ELECTRIC CO.'S ARC LAMP.



Duplex Arc Lamp.

THE arc lamp shown herewith is manufactured by the Duplex Electric Co., Limited, of Corry, Pa., to burn on either arc or incandescent circuits. The lamps are ornamental in appearance and simple in construction. They are fitted with hand cut-outs, automatic cut-outs, and automatic short circuit, which removes all resistance, as well as the lamp, from circuit when the carbons are consumed, and which allows single and "twin" carbon or all-night lamps being operated on same circuit with safety. The frame of this lamp is wide, and was especially designed to overcome the objectionable feature of casting large shadows. It is perfectly insulated, so as to be handled with safety when in circuit.

The carbons are fed by a train of gears that are controlled by differential magnets, which cause a uniform feed, and, consequently, a steady, noiseless, white light. These gears are connected so as to allow a rapid upward movement of the feed rack to facilitate trimming. They do not stick even when exposed to constant bad weather.

The "Duplex" lamp is easily adjusted to any length of arc desired, and when once adjusted it does not easily get out of order. It is made in two different styles, single and twin carbon. Both styles are made to give a light of either 1,200 or 2,000 normal c. p , and the twin carbon lamp is practically the same as the single carbon lamp with the exception of a carbon holder.

In the "twin" lamps the advantage is that when burning on one side of the twin carbon, the heat created by the arc heats the other side, and by being kept hot the arc is started before the eye can discern the change. As both sides are burnt to a point and apart, practically no shadow is cast except by the frame.

This lamp is highly appreciated by those who have used it, as, besides the above, it requires little time in trimming, is little liable to get out of order and is practically noiseless.

THE MILLIKEN PATENT POLES.

A VERY interesting and valuable pamphlet has been issued by Milliken Bros., of 55 Liberty street, this city, on their poles for electric railway and electric light plants. The subject of pole line construction and pole strength, is discussed in an able and instructive manner, and the various features of merit in the Milliken iron poles are carefully and fully set forth. The textual matter, which is in reality a brief treatise on iron poles, is accompanied by data of exacting tests made by Prof. Thurston, at Cornell University, and by a variety of diagrams, sectional views, and perspectives, showing just what the poles are and how well they look when up. The pamphlet is one of the best pieces of technical trade literature that we have seen in a long time. Most of the pictures have a familiar look, we may say, to the eyes of those who were recently delegates to the Buffalo Electric Light Convention, as the streets of Buffalo have some 5,000 or 6,000 Milliken poles distributed through them in electric railway work.

"JOHNSON SWITCHES."

WE have received a very handsome catalogue pamphlet of the above title from the Interior Conduit & Insulation Co., of this city. It is got up in the best Bartlett style. The subject-matter is the new Johnson "vise" snap switch which is attracting so much attention. The pamphlet contains a reprint from this journal of the excellent article by Mr. E. H. Johnson on his invention, together with details as to tests made, The arguments assembled in the pamphlet are made very convincing by the presentation of full size cuts showing exactly the dimensions of the 50 and 100 ampere switches, which under former conditions would not take care of a quarter of such a quantity of current, but which, on this new principle, do their work so well that they even seemed to be underrated by the makers.

SCHIEREN BELTS IN ENGLAND.

THE following is of interest as showing appreciation of American products in England:

THE ROUNDHAY ELECTRIC TRAMWAY,
LEEDS, ENGLAND, Jan. 16th, 1892.

MESS. CHAS. A. SCHIEREN & CO.,
47 Ferry Street,
New York, U. S. A.

GENTLEMEN:

We are ordering to-day from you a supply of your "Electric Belt Stuffing," also a supply of your "Belt Cement."

Will you kindly send us full instructions for splicing your Perforated Belts? It may interest you to know that the two belts furnished by you for this plant are giving every satisfaction, and have elicited considerable admiration from English engineers.

Yours truly,
THE ROUNDHAY ELECTRIC TRAMWAY,
J. E. WINSLOW, Manager.

GUM-ELASTIC ROOFING.

THIS material, first brought before the public twelve years ago, is now in use on buildings of every description throughout North and South America, and the fact that the demand is as great as ever seems to indicate general satisfaction. Gum-elastic roofing is made of felt, saturated with compounds of gum and dead oil, and rolled under hydraulic pressure until it becomes a strong, pliable, compact and cleanly material, unaffected by extreme changes of temperature, and absolutely fire and water proof. It may be applied by any ordinary workman, and is claimed to outlast tin, zinc and iron roofing, while costing considerably less.

The roofing, as well as the cement and paint of the same name, is manufactured and sold by the Gum-Elastic Roofing Co., of 39 and 41 West Broadway, New York City.

THE SOUTHERN ELECTRICAL MANUFACTURING AND SUPPLY CO.

THE above concern has its headquarters at 110, 112 and 114 Baronne street, New Orleans, with a factory in the same city. Mr. E. L. Bemiss is the president and Mr. W. Oswald, a pioneer motor man, is secretary, treasurer and general manager. The company undertake the whole range of electrical work. They are making a specialty of motors up to 5 h. p., but are principally busy on $\frac{1}{8}$ h. p. fan motors, of which they have already sold about 200 of their own make.

MR. CHARLES F. PEASE, formerly manager of the Westinghouse Electric Co., has been appointed general superintendent of the Interior Conduit and Insulation Co., with full authority over all the manufacturing, shops, etc. The company will immediately devote itself to getting out a line of special appliances, of the nature of the Johnson switch. Mr. P. H. Klein, who has been acting as superintendent of the company's factory, has resigned and will connect himself with one of the fixture houses.

SOMOFF'S INCANDESCENT LAMPS.

Mr. J. L. Somoff, of 1 Ann street, this city, is adding largely to his special makes of small incandescent lamps, of high and low voltages. Some of the new shapes devised by him are extremely pretty, so much so, that we can readily believe in their power to induce people to try new decorative effects for balls, dinners, lunches, receptions, etc. Mr. Somoff's prices are very moderate, and he deserves all the trade he can get.

THE BOSSERT LIGHTNING ARRESTER.

The approach of the summer season, accompanied, as it usually is, by heavy thunder storms, renders it advisable for the central station manager to make provision for the thorough protection of his lines and apparatus from lightning. Experience has taught that the best way to render lightning harmless, is to provide ready and easy means for its escape to the ground.

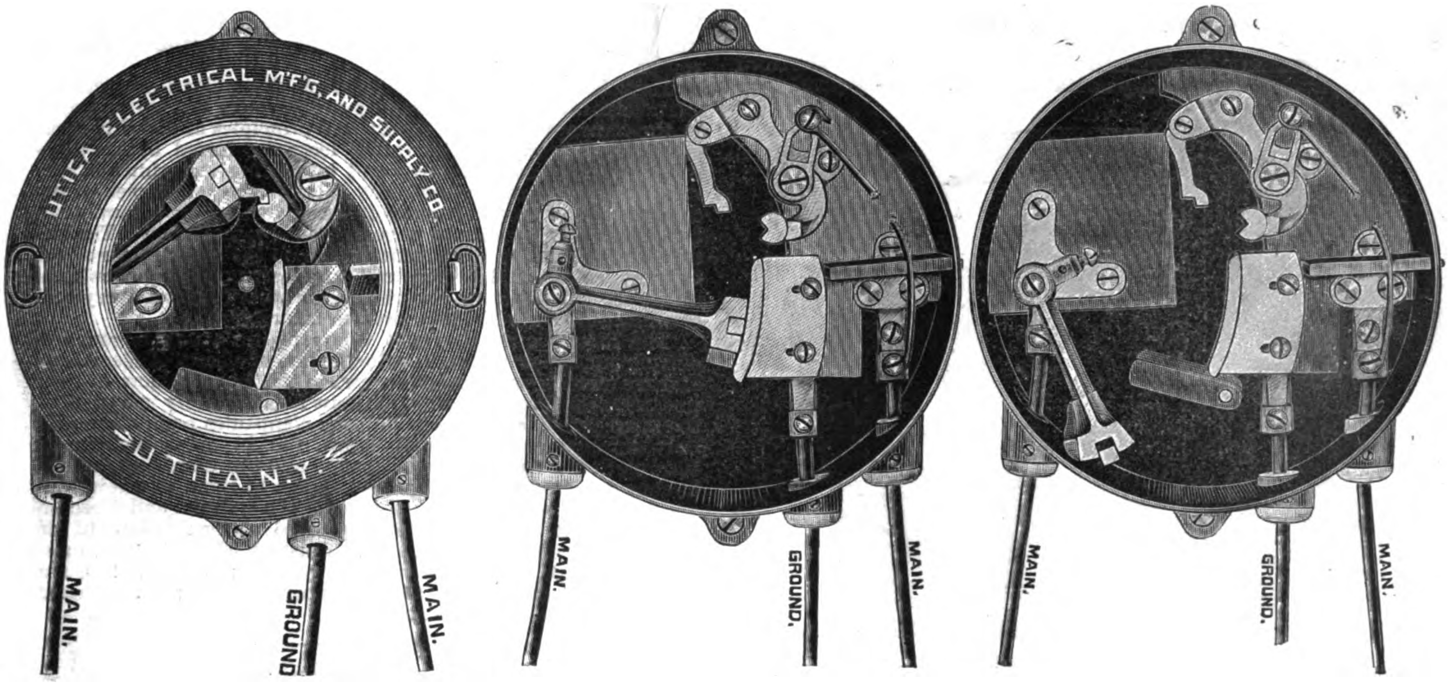
The Bossert lightning arrester, shown in the accompanying illustrations, is peculiarly simple and absolute in its action. No extra resistance is introduced into the line. The contacts are sufficiently large to carry heavy lightning discharges, the only injury to the apparatus being the melting of a fuse wire.

In the illustrations, Fig. 1 shows the arrester connected in circuit. The metal parts are mounted on slate bases and the whole is enclosed in water in a tight iron case.

Fig. 2 is designed for the protection of arc and incandescent circuits. It shows the position of the arrester after being struck by lightning. There is no resistance offered to the lightning, and the ground connection being perfect and quickly made, there is a ready means for its escape without flashing.

Fig. 3 is especially designed for the protection of railway generators and motors where part of the circuit is made by ground. In this arrester, ground connection is made just long enough for the discharge of the lightning and is then broken quickly in order to avoid the short circuiting of the generator. Arcing is prevented by a piece of slate actuated by a spring and interposed between the ground plate and the connecting arm.

These lightning arresters are manufactured by the Utica Electrical Mfg. & Supply Co., of Utica, N. Y.



Figs. 1, 2 and 3.—The Bossert Lightning Arrester.

THE INDURATED FIBRE PIPE.

The Fibre Pipe Company, of New York City, with works at Mechanicville, N. Y., are the sole manufacturers of fibre pipe, and they control exclusively the basic patents, taken out by H. J. Medbery, and others, covering all known methods of making fibrous pipe treated with a preservative compound. They are also sole owners of the McMahon patents on spiral paper tubing for interior conduits.

Briefly, the process of manufacture may be described as follows: The pipe is made from long fibres, separated, washed free from all saps and gums, moulded while in a pulpy state into the requisite size and shape and then subjected to great hydraulic pressure, after which it is treated and hardened by a chemical process that makes it completely impervious to moisture, acids or gas and without injurious effect upon wire or cable insulators. The weight of the pipe is one-fourth that of iron and is therefore more easily handled and transported to the trenches, ready for the laying.

It is considered that this pipe is perfectly adapted for the uses of an underground conduit for electric wires, and is believed to secure the greatest *safety, permanency and economy* in subways for the following reasons:

1. It is an absolute non-conductor of electricity.
2. It resists the action of the gases and acids of the earth.
3. Is not subject to disintegration.
4. It is moisture-proof throughout its entire structure.
5. The abrasion of its surface does not impair it.
6. It forms an absolute insulation for naked wires.
7. It does not contract or expand from thermal changes.
8. It is strong and light.
9. It has successfully withstood the test of five years for subway work.

We understand that electrical tests have been made by prominent electricians, and it has been reported that 2,000 volts had no effect on pipe shell three-eighths of an inch thick. The electrical resistance measured infinity. The breaking strain was found sufficiently high to prevent accidents from any ordinary weight or pressure. The screw or socket joints were found sufficiently strong and close for any underground pressure liable to occur. These and other results of tests were mainly from experiments with wires and cables for electric light uses; but the pipe is used largely for street railway, telegraph, telephone and special signaling systems.

The same company are also exclusive manufacturers of the Medbery patent "Multiple Duct" for electrical subways. New and specially designed machinery is used in the process, and fibre pipe of remarkable hardness and perfection of smooth ducts and close joints is produced in uniform lengths of five feet with ducts of various sizes and of any required number. Preference is given to the four duct pipe, round bore and square exterior, this form having already been determined upon by the telephone companies and others as convenient and economical for "building up" in subways.

The facility with which the pipe can be laid is one of the strongest points in favor of its use. The lightness of the pipe, its symmetrical form, and the ease with which tight connection is made by exact screw or socket joints, sealed with a small quantity of hot asphaltum, enable the laying of the pipe to be accomplished quickly and economically.

THE PENNSYLVANIA ELECTRIC ENGINEERING CO.

The Pennsylvania Electric Engineering Co. has been incorporated with $25,000 capital, and the following officers elected for the ensuing year: Arthur L. Bosley, president and manager; Benj. W. Tingley, vice-president; Lewis R. Schultz, secretary and treasurer; and Fredk. S. Koons, assistant secretary.

QUEEN & CO.'S TESTING SETS.

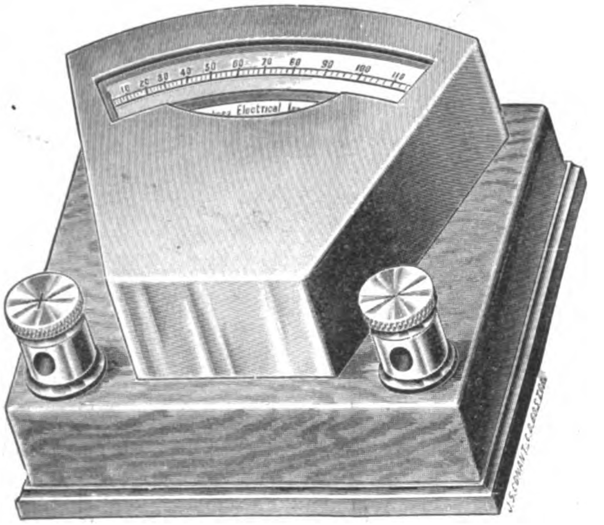
WE are informed by Queen & Co. of Philadelphia that their portable testing resistance sets still meet with great favor wherever they are introduced. The new style known as the "1891" type, which was brought out last fall, is especially appreciated as its peculiar construction has overcome many previous difficulties in both outside and inside testing. As is well known, great trouble has been experienced with the galvanometers usually supplied for such work, those with fibre suspension being too delicate for street use or where running machinery jars the station, and those moving on a central point being too sluggish. To overcome these defects, Queen & Co. devised a new galvanometer which, as has been proved by use, meets the requirements of all-around testing to a most satisfactory degree.

The features of this instrument which render it of such value are deadbeatness and sensibility. In consequence it is not affected by mechanical vibrations and proximity to masses of iron or intense magnetic fields, and can be used alongside of dynamos when running, in the streets of large cities, on shipboard and in fact everywhere. The coils in the rheostat and bridge are wound with platinoid wire and guaranteed accurate to one-fifth of one per cent. A special "reversing attachment," employed by Queen & Co. in their standard resistance boxes, is supplied, which gives a maximum range from .001 to 11,110,000 ohms.

The makers have just issued a neat circular No. 285 which sets forth the advantages of their testing sets, and we have no doubt they will gladly send a copy of the same to interested parties.

WHITNEY VOLTMETERS AND AMMETERS.

THE WHITNEY ELECTRICAL INSTRUMENT Co. of 35 Hartford street, Boston, with factory at Manchester, N. H., are placing on the market a voltmeter and ammeter intended specially to meet the growing demand for cheap but accurate apparatus, in stations, power houses, tests, etc. A cut is shown herewith. The instrument is direct reading and can be furnished to be used in either a horizontal or an upright position as desired. The divisions of the scale are very nearly uniform, facilitating close and accurate readings, and the low price of the instrument enables every user of electrical apparatus to make proper tests of it and of his circuits without feeling the expense of the necessary appliances.



WHITNEY VOLTMETERS AND AMMETERS.

"HARRISBURG" IDEAL ENGINES ON STEAMBOATS.

DURING the past few months, W. R. Fleming & Co., 174 Fulton street, New York, have been equipping a number of steamboats with their "Ideal" self-oiling automatic cut-off engines. The first boats supplied with this engine were the steamships "Yumuri" and "Maverick," of Ward's Line, which, proving to be perfectly satisfactory, have been followed by those of the Pacific Mail Steamship Company's boats, "Havana," "America," "Newport," "Para" and "Rio Janeiro" besides a new vessel not yet completed at Chester, Pa., and another at San Francisco, for which the engines have just been shipped. The Pennsylvanai Railroad Company have the "Ideal" engines on their new ferry-boats "New Brunswick," "Cincinnati" and "Chicago." The Spanish Steamship Line have the same engines on their steamers "Savannah" and "Ciudad Coudal" running between New York and Cuba, these being directly coupled to multipolar dynamos.

A NEW WIRT DYNAMO BRUSH.

PROBABLY the one thing about a dynamo or motor which causes more anxiety than any other is the tendency to spark and flash at the brushes. Numerous devices and lotions have been invented to smooth the sometimes ruffled temper of the commutator, but with indifferent success. Mr. Chas. Wirt has recently designed a new brush which seems to accomplish a great deal in this direction. It is manufactured by the Electrical Supply Co., and is meeting with an extensive sale. The company has received many letters from engineers and station managers expressing considerable satisfaction with the results obtained.

PARTRICK & CARTER CO.

IN our advertising columns last week will be found an illustration of the well-known and popular Partrick & Carter Co. patent needle annunciator. This firm are the only makers of the original needle annunciators which are made under U. S. patents of recent date which do not expire for some years. The features and advantages of this annunciator are too well known to require an extended notice. They are made up in various styles of cases and woods, with or without return calls and fire-alarms.

AN INTERESTING LECTURE ON ELECTRICITY.

THE first of a series of instructive lectures on the subject of electricity and its industrial applications was given on Saturday afternoon, January 30, to the employees of the Ries Electric Specialty Company, at their office and factory, Nos. 324 to 330 West Baltimore street, corner Eutaw, by the president of the company, Mr. Elias E. Ries, the well-known electrician and inventor.

These lectures, which are to be given at regular intervals, are intended to familiarize the young men and young women employed by the company with the theory and principles underlying their practical daily work. The initial lecture referred to was illustrated by numerous attractive and interesting experiments, and was thoroughly appreciated not only by the employees of the company, for whose instruction it was given, but by a number of ladies and gentlemen who were present by invitation. The lecture was held in the large testing-room on the second floor of the building, corner of Baltimore and Eutaw streets, which was fitted up for the purpose with electrical apparatus of almost every conceivable kind from Mr. Ries' private laboratory.

The Ries Electric Specialty Company are busily engaged in getting out a new and very valuable line of electrical specialties, and are meeting with much success in the introduction of their new regulating socket, which is now being rapidly adopted by the most prominent electric lighting companies and others, not only throughout the United States, but in many portions of Europe, South America and Canada, and the management is to be congratulated upon the interest shown by them in the welfare and advancement of their employees. The officers and directors of the company, which was incorporated under the laws of the State of Maryland in June, 1891, consist of Elias E. Ries, president; Lewis S. Greensfelder, vice-president; Leopold Ries, secretary and treasurer; David Myers, superintendent; and Herman Ries, assistant superintendent.

F. P. LITTLE & CO.

THE above firm of 141 East Seneca street, Buffalo, N. Y., have just closed a contract with the Western Transit Co. for lighting their city elevators "A" and "B." The contract includes a 7 by 12 Rice engine manufactured by the John T. Noye Manufacturing Co.; one E. I. cylindrical type Thomson-Houston dynamo; the necessary wiring and equipment for 300 incandescent lights of 16 c. p. and 4 arc lights to be run from the same circuit. F. P. Little & Co. are also to erect a 10 by 25 by 13 foot brick building in which to put the plant.

THE BERLIN IRON BRIDGE COMPANY.

THE TRUE BLUE MARBLE COMPANY, of Rutland, Vt., will replace the mill lately destroyed by fire, with an iron building, and have placed the contract with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be composed entirely of iron and marble, and will be 80 feet in width and 254 feet in length, the side walls being of iron and marble and the roof of corrugated iron. Not only the entire building will be of iron, but the framework inside for carrying the gang saws, shafting, etc., will be of iron, so that there will be no woodwork about the building in any way to take fire.

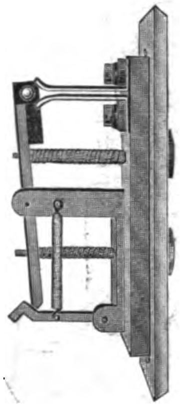
ENGINE AND BOILER WANTED.

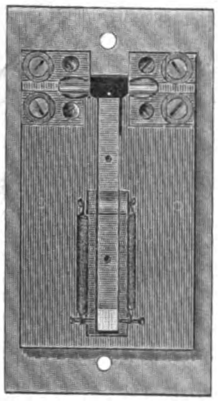
WE understand that the Excelsior Electric Co. of Harrison, N. J., are in the market for a 250 h. p. engine and corresponding boiler capacity.

THE "P. & M." PUSH-BUTTON SWITCH.

We illustrate in this issue an article long desired by the trade, for which there is a pressing demand and whose introduction will go far to obviate many defects of the present methods of incandescent lighting in finely furnished and decorated houses.

The Southern Electric Company, of Baltimore, Md., have patented and put on the market a push-button switch, under the trade mark of "P. & M." They are made of different sizes, from 5 to 50 amperes. The face plates are made of either brass, nickel, or oxidized silver. It is set flush in the wall and there is nothing to mar the harmony of the decoration. It is shown in Figs. 1, 2, 3 and 4.

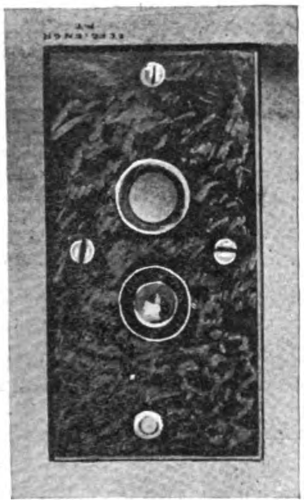


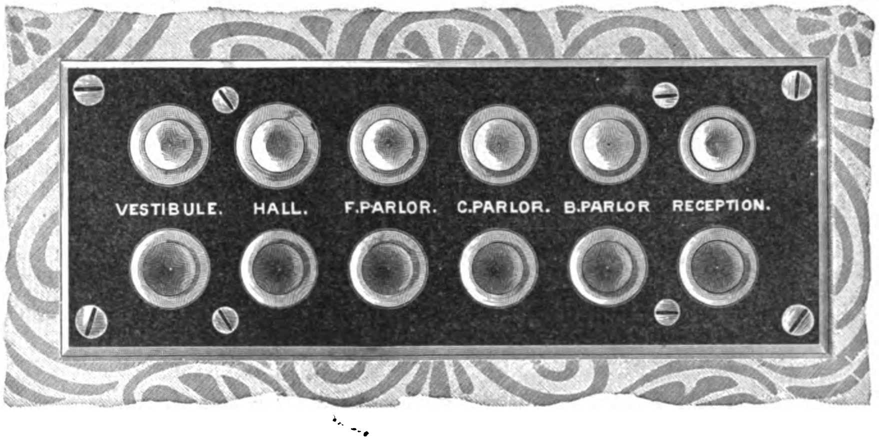


Figs. 1 and 2.—The "P. & M." Push-Button Switch.

Indeed, the only parts necessarily visible are the black and white buttons, whose condition—loose or firm—will indicate to the touch whether the light is lit or not. The switch is made either double or single pole; the mechanical movements are simple, exact and effective. The white button lights the lamps; the black one extinguishes them. The compactness of the article and the extreme simplicity of its details are all well shown in the cuts, all of which are half size.

One illustration shows a bank of six such switches as arranged in the residence of Gen. Thos. J. Shryock, Grand Master of Masons of the State of Maryland. In the small space of 3 x 8 inches it controls 30 lamps.





Figs. 3 and 4.—The "P. & M." Push-Button Switch.

SALES OF BALL ENGINES.

The following recent sales are reported by the Ball Engine Co., of Erie, Pa.: John Becker, Fitchburg, Mass., one 35 h. p. simple engine; Thomson-Houston Co., Boston, Mass., one 100 h. p. simple engine; Lewis Benedict, Attica, N. Y., one 80 h. p. and one 50 h. p. simple engines; William Howell Caldwell, Union City, Tenn., one 80 h. p. simple engine; Newark Electric Light Co., Newark, N. J., one 300 h. p. cross, compound engine; Hygeia Hotel, Old Point Comfort, Va., one 60 h. p. simple engine; Gale Shoe Mfg. Co., Haverhill, Mass., one 35 h. p. simple engine; Kittanning Electric Light, Heat & Power Co., Kittanning, Pa., one 150 h. p. simple engine; New England Conservatory of Music, Boston, Mass., one 35 h. p. simple engine; Columbia Electric Light Co., Philadelphia, Pa., one 200 h. p. simple engine; Osage Electric Light Co., Osage, Iowa, one 50 h. p. simple engine; Commonwealth Iron Co., Commonwealth, Wis., one 35 h. p. simple engine; Eugene Sites, Loraine, O., one 100 h. p. simple engine; Hix, Crosby & Co., Richmond, Va., two 60 h. p. simple engine; Edison Light & Power Co., Minneapolis, Minn., one 300 h. p. cross-compound engine; Schmidt Building, Pittsburgh, Pa., one 35 h. p. simple engine; Vandergrift Building, Pittsburgh, Pa., one 60 h. p. simple engine; Central District Telegraph & Telephone Co. Building, Pittsburgh, Pa., two 50 h. p. simple engines; Pittsburgh Iron & Steel Engineering Co., Pittsburgh, Pa,, one 80 h. p. simple engine; Industrial Improvement Co., Brockton, Mass., one 300 h. p. and one 100 h. p. cross-compound engine; Palace Hotel, San Francisco, Cal., one 200 h. p. cross compound engines; Halifax Mfg. Co., Lake Village, N. H., one 35 h. p. simple engine; Lockport Gas Light Co., Lockport, N. Y., one 100 h. p. simple engine; Electric Improvement Co., San Francisco, Cal., one 100 h. p. tandem compound engine; S. J. Lefevre, Gibson City, Iowa, one 100 h. p. simple engine; Edison General Electric Co., Portland, Ore., three 150 h. p. simple engines.

THE TRIUMPH COMPOUND ENGINE COMPANY.

The Triumph Compound Engine Company, of Cincinnati, O., report business as brisk. Their engines have been running in various parts of the country for several years and have practically demonstrated themselves to be all the makers claimed for them. Besides having improved their valveless engines where experience has shown it to be advisable, this firm is about to put on the market a compound automatic and a small single cylinder engine enabling them to more fully supply the various demands of the public. They are well equipped for this work, their shops being filled with specially designed tools, and their aim is to furnish engines of the latest and most approved design at prices that will place them within the reach of all.

AMSTERDAM, N. Y., NOTES.

Some quick repair work was done by the company during the recent storm which swept over Amsterdam. Almost simultaneously a falling pole demolished an arc circuit, while a ground on the railway line caused the breaking of a generator belt which tore away the brushes of an incandescent dynamo. In thirty-five minutes all three circuits were again running.

The central station of the company has been reconstructed and new foundations placed under each machine. Three new switchboards are soon to be built to control separately arc, railway and incandescent work. They will be built of wood, covered on the outside by a layer of asbestos, and all wiring will be done at the back.

The Amsterdam Street Railway Company will soon extend its lines to Rockton. A large number of the citizens favor the movement and on the hearing granted by the council on February 26, permission was given, and work begun at once.

Amsterdam has a long grade of 13¾ per cent. with two curves, probably the worst in the country. It has been found that when two motors of different speeds have been put on one car together, the hindrance has been very great in some instances.

THE HOGGSON PERPETUAL CALENDAR, DATE AND TIME STAMP.

In modern business methods there is nothing more important than to know with unfailing accuracy not only the date of the receipt of any communication, but also the exact minute that the matter was received. To accomplish this end, for several years past mechanical inventors have been working out and placing on the market various types of time stamps. These, however, were apt to be cumbersome and, owing to their being operated by a blow, often wore out and became inaccurate, and at the same time were exceedingly costly pieces of mechanism. To overcome these difficulties and produce a stamp of absolute reliability and accuracy, and at the same time at a price within the reach of all, Mr. Samuel H. Hoggson has perfected the instrument shown in the accompanying illustrations.

In the first place it is asserted that the stamps with metal type wheels, using an ink ribbon and operated by a blow were unreliable and incapable of indefinitely withstanding the hard treatment required to work them, together with the fact that printing the time and date in a straight line as they did, the impression occupied too extended a space to enable it to be used in postal service and on railroad tickets. For this service heretofore ordinary hand-stamps have been used exclusively. These stamps require to be set by hand at frequent short intervals, entailing a large amount of labor without giving the correct time, to the minute, and bringing in an extensive factor of error due to negligence, intentional or otherwise.

It was speedily determined that the keynote overcoming the above-mentioned difficulties could only successfully be struck by the introduction of an entirely new principle of printing, which has been successfully accomplished and is used in these new stamps. The entire working mechanism is contained in the head of the stamp, occupying the small space of 2 x 2⅛ x 3 inches high, thus entirely overcoming the objections to the large size of former stamps. The printing is accomplished by a set of endless rubber bands which are automatically moved by an electrically operated impulse device at intervals of one minute. These rubber type bands are entirely new and represent all the tedious work of producing such articles accurate to $\frac{1}{10000}$ of an inch, something unheard of before in rubber manufacture.

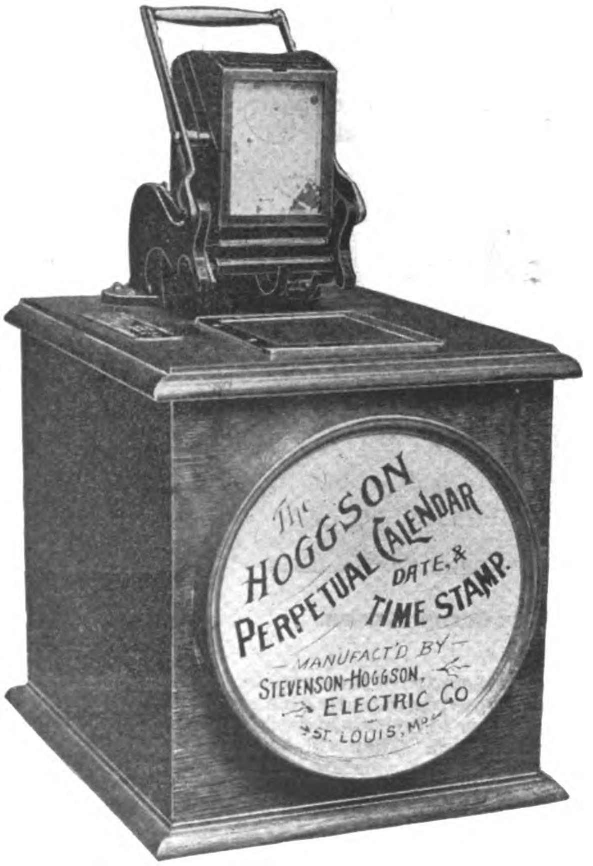


Fig. 1.—The Hoggson Perpetual Calendar, Date and Time Stamp.

By the aid of these bands the date and time complete can be printed clearly and distinctly in a space which can be covered by a silver quarter, and, being of rubber, as are also the dies, the impression is obtained by a gentle pressure. It will print nicely on uneven surfaces, such, for instance, as envelopes with inclosures, where metal die stamps signally fail. The machine will print readily any sized die up to 2 x 2⅛ inches, an impossibility with any metal-wheel stamp. The dies are interchangeable and can be removed and replaced instantly. Any number of dies can be used with a single machine. The stamp automatically changes the minutes and hours, and at 12 o'clock midnight, changes the day. It requires setting once a month to change the months and five times a year the day hand must be set to conform to the long and short day months. The changes are made with the same facility as setting a watch and take but an instant.

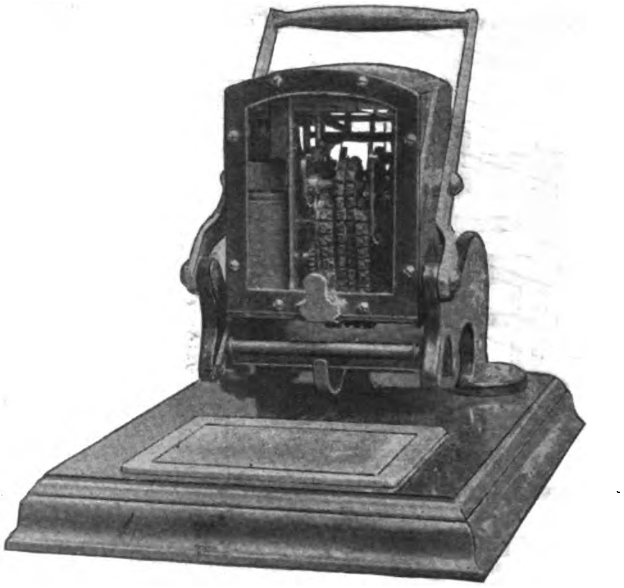


Fig. 2.—The Hoggson Perpetual Calendar, Date and Time Stamp.

As the machine stands before the user, it is not only a time-stamp but a perpetual calendar and time-piece, the dials on the face showing the month, day, hour and minute, correct time, and denoting the impression which the stamp will make at any instant, thus showing the operator at a glance whether the machine is running correctly, and just what it will print without taking an impression, thus avoiding any possible error.

These machines will run with two cells of battery and are also constructed to operate upon an open or closed circuit with either batteries, direct or alternating current lighting circuits, or storage batteries; in fact on any system containing sufficient power to ring an electric bell; and can also be run on any electric time or signal circuit. All the stamps in one building, block or entire city, may, if desired, be operated by one master clock. No special clock is required, it simply being desirable to have a correct time-piece, as the machine would otherwise record the errors of the clock.

All portions of these machines are manufactured on the interchangeable system, are as accurate as watch or clock work, and are not complicated or liable to disarrangement.

These time stamps are patented in all parts of the world and are manufactured by the Stevenson-Hoggson Electric Company, 919 Olive street, St. Louis, Mo.

A. J. VENEMAN.

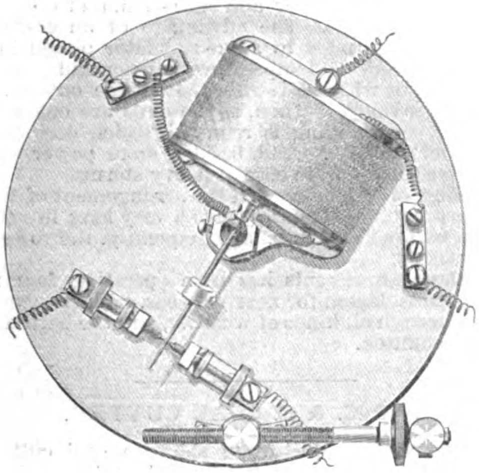
Mr. A. J. Veneman has just started a construction and supply business at 326 Main street, Evansville, Ind. His concern will carry a complete line of electrical supplies and will increase its stock as demand justifies. It will also contract for construction work of all kinds and install isolated and central station plants. Mr. E. L. Masters has been in the electrical business for about ten years; for the past three years he has held the position of superintendent of construction with the Evansville Gas & Electric Light Co. Mr. A. J. Veneman has also been connected with the same local company for about four years, but for the past year was with the Electrical Supply Co., Chicago, which experience has enabled him to attain a thorough knowledge of electrical supplies of every description.

THE MONTREAL CONVENTION.

Mr. A. J. Corriveau has issued a very pretty and interesting souvenir of the meeting of the National Electric Light Association at Montreal last September. It is well illustrated with portraits, landscapes, glimpses of the electrical exhibition, etc. All who were at Montreal will be glad to have it.

THE RITCHIE POTENTIAL INDICATOR.

It is essential to the successful working of an incandescent system that the pressure on the circuits should be maintained as nearly uniform as possible, and in order to do this in the most satisfactory way, a reliable pressure indicator is almost indispensable in an electric lighting station. To meet this requirement Messrs. E. S. Ritchie & Sons, of Brookline, Mass., have designed and perfected the instrument which is shown in the accompanying cut. The instrument is made in several different forms, though the principle by which it works is the same in each case. A coil about 3½ inches in diameter which holds the moving parts is mounted upon a slate base eight inches in diameter. This base supports and insulates the contacts and wire connections as shown in the cut. Where the instrument is exposed to dust it is found better to inclose the index-arm and contacts in a dust-proof case, and another form is made in which this is done and in which at the same time by removing a cap the contacts are at once exposed for adjustment when necessary. The base is held to the wall or switchboard by a bolt through its centre on which it turns by means of the long tangent screw. The adjustment of the instrument is very simple and easy and it will work practically without variation inside of one-half volt either above or below the voltage to which it may be adjusted and is singularly free from error due to vibration of building or switchboard. The instrument is kept constantly in circuit and the change in pressure is shown by red or green lights, as the variation is above or below the normal, the right pressure being attained when there is no light shown, thus avoiding the danger of running lamps above their normal candle-power. For house installation for electric lighting another form is made which is very cheap and satisfactory without the contacts and lamps, the pointer indicating on a graduated card simply high, right or low. It is claimed for this instrument that it is easy of adjustment, free from error due to vibration, and shows less error due to temperature, shows the change in the circuit pressure closely and quickly and is at the same time handsome and well made. These points have been determined after tests under the most severe conditions, extending over a period of many months in an electric lighting station where the instrument was left entirely in the hands of the superintendent of this branch of the electric lighting work.


The Ritchie Potential Indicator.

THE WESTON INSTRUMENTS ABROAD.

In a recently issued volume of the *Journal of the Institution of Electrical Engineers* of London, there appears an interesting discussion on a paper read in November last before the Institute, by Messrs. Sankey and Andersen, on the standard volt and ampère meters used in the establishment of Messrs. Willans and Robinson at Thames-Ditton. In the course of the discussion Mr. Evershed paid a high compliment to the good qualities of the apparatus of Mr. Edward Weston. He said:

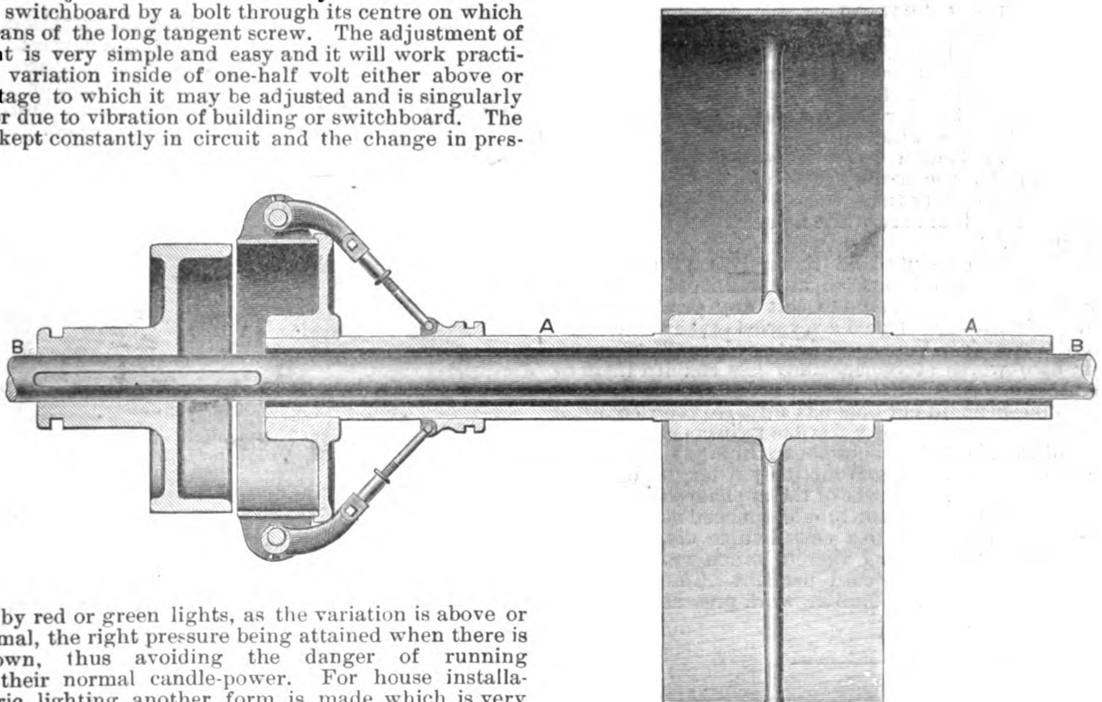
> "There is one species of d'Arsonval galvanometer which does not hail from France, nor is it an English copy of French instruments. It is made in America. We always assume that Americans cannot make instruments, and that may be true generally; but there is certainly one American who can, and that is Mr. Weston. His voltmeters are only d'Arsonval galvanometers in which the current is led in by two phosphor-bronze hair springs, which also act as the controlling force. Instead of the clumsy mirror and scale, a light aluminum index is fixed to the coil, and reads on the scale like an ordinary commercial instrument. The instrument I tested could be read to a quarter volt quite easily over the whole scale ranging from 0 to 150 volts, and I think that is quite comparable with the accuracy Captain Sankey mentions for readings with mirror and scale with d'Arsonval galvanometers in ordinary practice. Not only is the scale of the Weston instrument accurate, but the volts too are accurate. Mr. Weston calibrated this voltmeter in February last, and I tested it three weeks ago and found his volts agree with ours to .05 per cent. I think it is due to Mr. Weston to bring that to your notice."

We may remark parenthetically, that while Mr. Weston is an Englishman by birth, it is certain that what he knows about making instruments has been learned by him in America. It is gratifying to know that his patient, careful and thorough work in the line of measuring apparatus is becoming appreciated abroad as well as it is at home.

THE HUNTER FRICTION QUILL.

The accompanying illustration shows a form of shaft coupling adapted to places where heavy power is to be distributed on either side of a main driving pulley. As will be seen, the quill is supported on bearings at A A, and is entirely independent of the main shaft B B, except through the medium of the clutch. By this arrangement, there is absolutely no wear when the pulley is at rest, and, of course, no lubrication is required between the shaft and the quill.

An especial feature of the clutch is the use of two shippers, by means of which the drum may be withdrawn from under the friction bands, thus dispensing with oil when not in use. The grip of this clutch is claimed to be the strongest in existence.



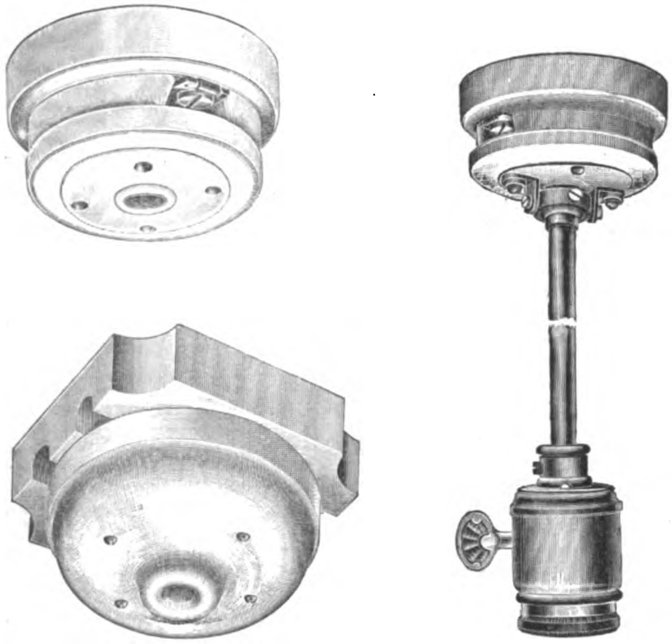
The Hunter Friction Quill.

The Hunter friction quill is manufactured by Messrs. H. N. Bates & Co., of 240 Congress street, Boston, whose New York office is at 126 Liberty street.

The Springfield Street Railway will equip eight miles of new line in the spring.

EDISON CEILING CUT-OUTS.

Recognizing the possibility of the increase in the demand for ceiling cut-outs the Edison General Electric Company designed and patented one some years ago, embodying many of the fundamental principles underlying all cut-outs devised for a similar purpose. Recently the old form of single-pole pendant cut-out was superseded by a double-pole cut-out of a novel shape, especially devised for cleat work and possessing additional recommendations and advantages, as shown in Fig. 1.



Figs. 1, 2 and 3.—Edison Ceiling Cut-Outs.

It is claimed that this cut-out can be sold as cheaply as the cheapest ceiling cut-out in the market, without depreciation of quality. This was followed shortly afterward by two new double pole cut-outs, one for moulded, and the other for concealed work. These are of special design and of superior workmanship to that mentioned above, their interior construction, however, being similar. The contact-pieces in the porcelain base are flat, and are provided at their terminals with small indentations which serve to catch and retain the bent contact-pieces in the cover and make a perfect contact. Two safety fuses protect the appliance. The cut-outs are made of the best hard white non-absorbent porcelain, and are shown in Fig. 2.

The two last named cut-outs lend themselves with peculiar facility to decoration. The Edison Company will shortly be ready to supply decorated ceiling cut-outs to suit any or all requirements. The designs already selected are varied and artistic. The establishment of a porcelain factory under their immediate supervision in their own works at Schenectady has enabled them to bring these cut-outs to a high state of perfection.

The use of ceiling pendant cut-outs has hitherto been confined to lights hung from the cut-out by a flexible twin conductor. The flattened shape of the No. 123 cut-out shown in Fig. 1, admits of use with a swinging light hung from it by a length of metal tubing. To effect this end, the cover of the appliance is provided with a universal joint, to which the tube is attached as shown in Fig. 3. The light can be swung to a considerable distance from its normal point of rest, returning thereto much more quickly than is the case with the flexible cord pendant. The many advantages for store lighting and similar work presented by this arrangement are obvious.

ELECTRIC HEATING.

A very interesting and handsome pamphlet on the subject of electric heating has been issued by the Burton Electric Co. through their selling agents, the Electric Merchandise Co., of Chicago, with reference to the celebrated Burton heaters. It gives views and descriptions of the apparatus as applied to street cars, and quotes a large number of testimonials from various electric roads using the system. It also includes three very interesting newspaper articles on the general subject, one being that which Mr. W. R. B. Willcox contributed to our columns some months ago, and which attracted no little attention.

A TOWER CLOCK OPERATED BY AN ELECTRIC MOTOR.

For some months the Standard Electric Time Company, of New Haven, Conn., have been making careful tests with a special electric motor driven by current from open circuit batteries, to operate tower clock dials. Few tower clocks are found to indicate correct time, but vary considerably unless constant attention is given them. This is partly on account of their being exposed to the extremes of temperature. Besides this, they must be wound up every week, which is no small "chore," and considerable sums are paid yearly for this labor and attention, and even then the clocks are seldom right. The advantage of an electric tower clock is that it is controlled by a fine regulator placed in a room in the building where the temperature is even and means are at hand for keeping it within a few seconds, at the outside, and the tower clock must follow. Then, as the dials are operated by an electric motor, no winding is required, which does away with much labor and expense. And, besides, more power can be delivered to drive the hands in case of heavy storms.

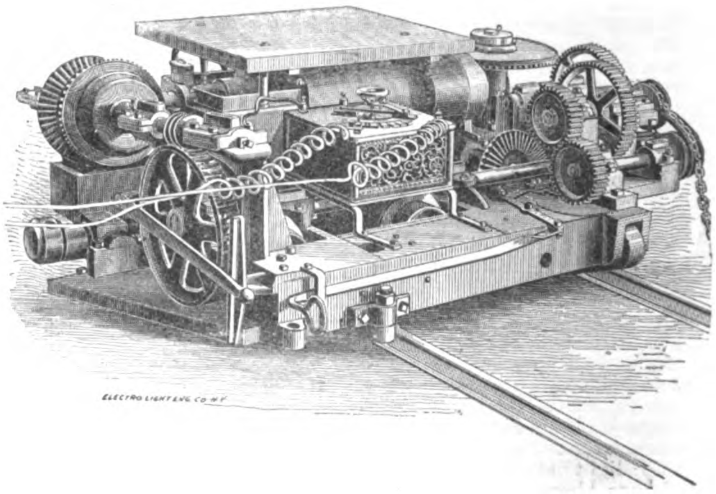
The winding of the motor and the arrangement of the power from it is such that the batteries have a very long life (from one to two years without renewal). Consequently, the tower seldom needs to be visited.

One of these movements has been operating four nine-foot dials at Lawrence, Mass., for nearly a year, and has given perfect satisfaction through all kinds of weather, and the batteries are yet in excellent condition.

THE C. & C. COAL CUTTER.

The accompanying illustration shows a coal cutter of the undercutting type driven by a 15 h. p. C. & C. electric motor of special design, in operation in the Mead Run Mine in Pennsylvania. The motor, placed in position on the machine, is covered by a heavy board which serves to protect it from possible injury. The starting box is also placed on the machine in a convenient position, as can be seen from the illustration. The armature shaft carries a beveled pinion at each end, and, by a mechanical device, this can be made to operate the endless chain to which the coal-cutting knives are attached and which revolves about the arm, and also to operate the feed chain which is made fast at one end, so that the machine can be moved forward at any desired speed, or allowed to remain stationary if the hardness of the coal so requires. The potential of the electric motor being low, 220 volts, there is no danger to be feared from coming in contact with the wires.

The knives used for cutting are of the greatest durability, and, when dulled, can readily be replaced by a new set. By using this style of machine the necessity and inconvenience of moving by hand in a low room is avoided, and the track on which it travels is such that it can be easily laid or moved as desired. Two men operate the cutter, one regulating the speed of the gears and the other attending to the moving of the machine.



The C. & C. Coal Cutter.

The Thomson-Houston Electric Co. have found this machine so successful in mines where an undercutting machine can be used to advantage that they have made an arrangement for its adoption, and it is expected that several mining machinery manufacturers will do the same.

Schleicher, Schumm & Co., manufacturers of the Otto gas engine, have opened an office and salesroom at 19 Pearl St., Boston, Mass.

WESTERN NOTES.

Mr. C. E. Sargent, manager of the Chicago office of Messrs. A. L. Ide & Son, has received the following orders for Ideal engines since the beginning of the year: E. W. Blatchford, one 55 h. p. for incandescent lighting; Winslow Bros., one 35 h. p. for electroplating; the Sperry Electric Mining Machine Co., one 100 h. p. for an electric haulage and mining plant; Groveland Apartment Building Co., one 35 h. p. and one 55 h. p. for incandescent lighting; Hyde Park Electric Light and Power Co., one 250 h. p. tandem compound for arc lighting; Thomson-Houston Electric Co., two 125 h. p. engines and a complete plant for an electric railway; the National Electric Mfg. Co., two 100 h. p. for an alternating incandescent plant; and the Bavarian Brewing Co. one 85 h. p. During the past week, two 80 h. p. Ideals have been placed in the Unity Building for incandescent lighting; three 100 h. p. Ideals in the Ashland block for incandescent lighting; one 100 h. p. in the Arc Light and Power Co.'s Market street station; one 55 h. p. in J. S. McDonald & Co.'s new factory for incandescent lighting, and one 100 h. p. and one 150 h. p. in the Grant Locomotive Works for lighting and furnishing power for three electric cranes.

The Great Western Electric Supply Company, Nos. 201 to 207 S. Canal street, report a most gratifying increase in the demand for their electrical goods, especially their Sun arc lamp, which can be used singly or in series and gives a most beautiful, steady, white light. They are also receiving large orders for a new focusing arc lamp, several of which are in use in various parts of the city. There is also an ever-increasing demand for their celebrated K. K. wire. They are doing a large business in house-goods supplies, and the sales are increasing daily. The fixture department reports very large sales in Missouri, Louisiana and Illinois. The business of this year compared with last shows a big gain, while the outlook for 1892 is better than it was this time last year.

H. T. Paiste's Western Office.—Mr. Paiste is well known to the electrical fraternity as a pioneer in the application of beauty and art of invention. The artistic appearance of his Western office at once strikes the visitor as he enters. The display of china switches, both in a handsome showcase and upon a neat sample board, gives evidence of the art of decorating, of which Mr. Paiste is the master. The unique method of advertising his china switches by well-executed outline drawings of Chinamen well deserves special notice, and we understand that central station men and purchasers will have the pleasure of seeing Paiste's Chinaman figuring in the advertising columns in the near future.

Camden, Ark.—The electric light plant of the Camden Electric Light and Power Co., Camden, Ark., was seriously damaged by fire on January 24th. Steps were immediately taken, however, to resume operation, and it was decided to equip a new and independent plant. Formerly the steam was secured from the water-works boilers, but the company will now put in its own steam plant, having ordered two 60 inch x 16-foot boilers, and a No. 7 Hoppes exhaust heater, from the Pond Engineering Company, through its Dallas, Tex., office. The engines, while considerably damaged, can be repaired.

Mr. A. H. Englund, formerly secretary and treasurer of the Electric Merchandise Co., Chicago, has opened an office at 435 "The Rookery," as secretary and manager of the International Register Co. This company have purchased the Pratt patents on conductors' fare registers and have equipped a very complete factory for the manufacturing of these machines in both portable and stationary forms. Mr. Englund's long and practical experience in the street railway supply trade has made him a host of friends and the success of his new enterprise is assured.

The Electric Appliance Company are introducing something in the line of a combination branch block. As at present constructed the block is adapted for eight circuits, although other sizes are in course of construction. It is about 8 x 12 inches, made of hard porcelain, with highly-polished oak or cherry cover. This block can be placed on the wall or in other suitable places, requires but very little space and when connections have been made the cover is fastened on by screws, making a very neat and substantial job.

The Electrical Appliance Company have completed arrangements to represent the Cutter Electrical Specialty Company of Philadelphia in the West, and will hereafter carry a full line of the Cutter portables, reflectors, flexible brackets, etc., for which a very large demand has already been established. To those familiar with the Cutter specialties, it is not necessary to state that they are a line of very desirable articles.

The Electric Appliance Company report having just closed arrangements with the Ries Electric Specialty Company to control the sale of their socket in certain Western territory, and are making active preparations to thoroughly introduce this valuable specialty. They will carry a large stock on hand in Chicago at all times.

W. B. Pearson & Co. have just closed a contract for complete steam plant for the city of St. Charles, Ill., who are installing a lighting plant. The engine furnished is one of 80 h. p. Ball & Wood single cylinder. This deal was closed by Mr. H. E. Jefferson for his company, and his bid was the highest. It reflects great credit on his abilities in convincing people that they must have Ball & Wood engines.

The Electric Merchandise Company are doing a very large business, especially in the East in electric street railway supplies, which they deal in exclusively. Mr. W. R. Mason reports a very brisk demand for Burton electric heaters for car service from all parts of the country, and says that electric heating is now acknowledged to be the ideal in every respect.

Mr. Chas. E. Wilson, widely known throughout the West among central station and street railway men, has accepted a position with the Electric Merchandise Company as general traveling representative. Both Mr. Wilson and the Electric Merchandise Company are to be congratulated on this connection.

The belts for the new Leiter Building, comprising two 48-inch main belts and ten 14-inch dynamo belts, were furnished by the Chas Munson Belting Company, who thus have the distinction of belting up the largest isolated plant in the city. This order was secured in the face of the keenest competition.

The Chubbuck Malleable Iron Brackets still continue to hold popular favor and are used by nearly every company in the country. They are far superior to cast iron, being both lighter and stronger. The Great Western Electric Supply Co., Chicago, are general agents for these goods.

The Central Electric Company in preparation for the coming spring business have laid in a large stock of all classes of supplies, such as hard rubber tubing, Banner weatherproof wire, Bryant sockets, switches and cut-outs, expanding wire guards, Swan lamps and Washington carbons.

The Electrical Supply Co. are receiving numerous orders for their favorite specialties, comprising Sunbeam lamps, Shield brand line wire, Stanley transformers and Habirshaw rubber-covered wires and cables. In general electrical supplies of all kinds the demand is very brisk.

Mr. George McKinlock, of the Central Electric Company, says that his company are experiencing an excellent activity in general supplies and a very brisk demand for specialties, and Okonite is as usual keeping up its record.

The Central Electric Company report being well equipped to handle all orders for carbons of all the standard sizes, having a large stock of molded, both plain and coated, made by the Washington Carbon Company, for whom they are general Western agents.

The Ernest L. Clark Company, of 540 The Rookery Building, report a large and increasing trade in all kinds of iron and cedar poles. In Dubuque, Iowa, alone, they have closed contracts amounting to 30 car loads of metal in the past week.

Mr. F. E. Drake has accepted an appointment as district manager of the Rockford Electric Mfg. Co. of Rockford, Ill., with headquarters at No. 451 Rookery, Chicago, Ill.

The Electrical Supply Co. are furnishing a great many Stanley transformers, which are giving very excellent results.

HUDSON RIVER NOTES.

Hudson, N. Y.—The Hudson Electric Railway has been contemplating the extension of its lines to Fillmont, a distance of nine miles, but the recent law of the Legislature forbidding an excess of five cents being charged for fare will prevent such a move at present. Probably few roads can show, like the Hudson, a net profit of 57 per cent. above operating expenses. Their four cars have made an average of 117 miles a day for a year and a half without the loss of an armature or field. The motorman has the entire charge of a car while the trolley looks out for itself, and seldom makes an attempt to get off the wire. The managers think that this method makes the motorman more careful about entering switches and turnouts and is thus much easier on the machinery.

Troy and Lansingburgh Railroad Officials have been looking over the ground and inspecting Broadway and Union streets for the purpose of locating the tracks to form the new loop to the depot, and as soon as the weather will permit the work will begin, and be pushed to completion as rapidly as possible. It is stated that it will entail considerable study to arrange the schedule so as to accommodate passengers from both ends of the line and at the same time suit the requirements of the company. During the coming summer work will be pushed on all the contemplated branches, but the depot loop is considered of the most importance at present, and will be taken in hand first.

NEW YORK NOTES.

H. Ward Leonard's method of electric motor control, which he exhibited for the first time at the Montreal Convention and upon which he has recently secured broad patents, has met with great favor at the hands of the electric elevator people. Mr. Leonard has granted licenses to the Otis, Crane, Hale, Stokes and Parrish and Whittier Elevator Companies, and electric elevators operated under Mr. Leonard's method are being rapidly introduced by these companies. This elevator is popular with the central station managers, as it uses so small a current in starting up the elevator as to have no effect upon electric lights on the same circuit. By Mr. Leonard's method an electric elevator can be operated from an Edison three-wire circuit, an arc circuit, a railway circuit or an alternating circuit, which gives it an exceptional flexibility. The capital of H. Ward Leonard & Co. has recently been doubled and the increase taken by gentlemen prominent in the leading railway, banking and gas interests of New York City.

The Interior Conduit and Insulation Co. have issued a new set of specifications for wiring for electric light, employing their conduit system. It is very complete in its provisions, and if lived up to by those who do the work should ensure a most satisfactory and perfect installation. The details of the interior conduit system have been so carefully worked out that the company believe it leaves no opportunity for just criticism but meets all requirements. The Interior Conduit Co. make the point however that their system of wiring should be used in its entirety, and that contractors should follow these rules to the letter.

Emil Gabel & Co.—This is a new concern established by Mr. Emil Gabel, a veteran belting man. It will be sole Eastern agent for the celebrated "Monarch Rivetless" and "Bradford Dynamo" leather belting, and will carry also a line of lace leather and general mill supplies. It will have a temporary office at 96 Centre street, but after May 1 will be installed at 44 Dey street. A circular issued by the firm contains two testimonials as to the Bradford belts, from the Brush plant at Cincinnati and the Brighton, O., electric railway station.

The Dreher Manufacturing Co. of 37 Platt street, this city, are introducing a very fine grade of specially refined lubricating oils, which should prove valuable to those who have dynamos and other high-grade machinery in their charge. They are moreover making an oil for dynamo use exclusively, which is the result of many months' of experimenting and compounding. The company employ a corps of analytical chemists in their work, and guarantee their oils as in every way of the highest and best class.

The Electric Merchandise Company, of Chicago, is making considerable of an Eastern "hit" for a Western concern. But it is an active progressive house and has invaded every State. Many new roads are specifying its overhead fixtures, whatever system they adopt, which is the best sort of a testimonial. All speak well of the company and its equipment. Already, it is unexpectedly busy with a new season's business.

Mr. W. W. Nugent, a consulting and contracting engineer of prominence, has been appointed the sole agent for the celebrated Goubert water-tube feed-water heaters, vertical and horizontal, in Chicago, his office being located at 823 Home Insurance Building, that city. The Goubert Manufacturing Company find a demand for their heaters, which is keeping them busy at their New York headquarters, 32 Cortlandt street.

T. J. Murphy, maker of slate switchboards, says that by marbleizing the slate, the moisture resisting qualities are greatly increased He also suggests the application of a coat of paint on the back of the board after all the boring is finished. By doing this the holes are saturated, and when the instruments are assembled thereon the entire surface is practically moisture proof.

Mr. W. C. McIntire has resigned as manager of the New York office of the Eddy Electric Manufacturing Co., owing to the demand made upon his time by his personal affairs in Philadelphia. He is now removing his offices permanently to the latter city, and will handle the motor there and for the South. Mr. F. C. Ross succeeds him in charge of the New York office.

Mr. Unico H. W. Schenck has become the New York agent for the American Leather Link Belt Co., whose principal offices are at 46 and 48 Ferry street, and who are now the sole manufacturers of the American joint leather link belting, which they guarantee for hard work of all kinds.

Mr. E. L. Burrell, manager of the Western office of the Chas. A. Schieren Belting Co., who spent a few days in New York after the close of the convention at Buffalo, has returned to Chicago. He was able to report an excellent trade and the outlook most promising.

The American Manufacturing and Engineering Company have removed from 15 Cortlandt street to Central Building, 143 Liberty street, opposite the Pennsylvania and New Jersey Central and Baltimore and Ohio Railroads.

PHILADELPHIA NOTES.

Warren Webster & Co., 491 N. 3d street, Philadelphia, Pa., are the sole licensees of the Williams vacuum system of steam heating whereby they guarantee to heat buildings without back pressure upon engines, and increase the efficiency of the heating surface. They put the system in on trial, and during the past few weeks have booked orders from the following firms: Windsor Folding Bed Company, Chicago, Ill.; Hawley & Hooper, confectioners, Mulberry street, New York; W. L. Kann & Co., Pittsburgh, Pa; Journal Building, Jersey City, N. J., through W. W. Farrier, steam heating contractor, Jersey City, N. J.; Joliet Enterprise Company, Joliet, Ill.: Simson Nickel Manufacturing Company, Wallingford, Conn.; N. C. Penitentiary, Raleigh, N. C.; Wood, Jenks & Co, Cleveland, O.; Insane Asylum, Raleigh, N C.; The Cooper Hospital, Camden, N. J.; Cramer Company, Norfolk, Va.; Robert Gair, Manufacturing Stationer, Brooklyn, N. Y.; Eckington and Soldiers' Home Railway Company, Washington, D. C.; Pencoyd Iron Company, Pencoyd, Pa.; Elba Iron Company, Pittsburgh, Pa.; Krann & Bro., Philadelphia, Pa.; Baltimore and Potomac R. R. Station, Washington, D. C.; H. P. Nail Company, Cleveland, O.

Mr. Chas E White, formerly sup't of the Pottstown Electric Light, Heat & Power Co., has accepted the position of salesman for Otis K. Stuart, who is manager for the Germania Electric Co. for the Southeastern district.

Mr. Otis K. Stuart has secured the agency for John O. Heinze & Co., of Lynn, Mass. The firm manufacture electrical measuring instruments, Wimshurst machines, induction apparatus and a general line of experimental electrical appliances. Mr. Stuart will be general selling agent for these goods and parties interested should communicate with him.

W. H. Weston & Co., manufacturers of electrical appliances, etc., are now at work on a new illustrated price list which will be ready to distribute about March 20. This enterprising firm report business brisk, with some night work.

The Pennsylvania Electric Engineering Co. has just been awarded the contract for furnishing the electrical department of the city of Philadelphia with supplies for the year ending March 1, 1893.

ST. LOUIS NOTES.

The Emerson Electric Manufacturing Co. have just issued their first annual catalogue which is a well-arranged pamphlet of eighty pages. As a frontispiece are given two excellent photo-engravings, one representing the feeder switchboard of the Lindell railway power plant, and the other the switchboard of the lighting plant of the Cupples Building, both of which are models of simplicity in design and excellence in construction. Following the title page is given an introductory and special advice to purchasers, after which follows the catalogue proper, which is divided into six divisions—appliances for electric lighting, appliances for electric railways and power plants, electric railway line supplies, alternating current motors, special apparatus, and the engineering department—in which appear the names of E. J. Bagnall and A. W. Meston as consulting electrical and mechanical engineers.

The Emerson Electric Manufacturing Co. have increased their capital stock to $75,000 and elected the following officers: J. W. Emerson, president; C. R. Meston, secretary; A. W. Meston, superintendant. The business of the company has increased steadily throughout the year, so much so that they were compelled to seek larger quarters last fall. In their new quarters at 1110 and 1112 St. Charles street, they have ample room and facilities to handle their largely increasing business. Their new catalogue will be issued shortly.

The Stagl Engineering Co. has removed to 408 North Eighth street. They have been kept pretty busy during the past few months. One of their recent orders is for a 200-light incandescent plant for the American Brewing Co., of St. Louis, and another is for an 8 h. p. motor for the hard lumber firm of Smith & Little, in North St. Louis. The dynamo and motor in these plants are of the Card Electric Motor Co.'s make and are giving full satisfaction. The Stagl Company are also busy wiring a number of new buildings.

J. H. Siegrist, Jr., & Co., St. Louis, have recently sold Bristol recording pressure gauges to the Springfield, Ill., Electric Light and Power Co.; two to the Ottumwa, Iowa, Electric Railway Co., and one to the Central Distillery Co., of this city.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

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THE ELECTRICAL TRANSMISSION POWER PLANT AT THE CHICAGO WORLD'S FAIR GROUNDS.

BY

H Norman Collins.

I.

EVIDENCES that electricity as a means of transmitting power is becoming the prime favorite are more numerous every day. On all sides large factories, mills and other manufacturing establishments are adopting the ever-ready motor to perform their various work, and discarding the long lines of shafting with its complex arrangements of belts and pulleys. One of the largest engine and mining machinery manufacturing companies in the world has recently equipped its new factory entirely with electric motors on account of their great economy, reliability and safety. In town and cities all over the country the power load of the central stations keeps steadily creeping up and is becoming a more and more important factor in economical operation, and the sub-title of "Power" which but a short time ago was merely a sign, now possesses an exceedingly positive meaning. It is for these reasons that the engineers of the Construction Department of the World's Fair determined from the first, that the power required for building the Exposition structures and performing all labor connected therewith should be entirely furnished by means of electricity, as being the most modern and perfect agent to perform the work expeditiously and economically.

It has been the good fortune of the writer to examine carefully the plant in all its details of generating and receiving machinery and watch the various electrically-driven devices in operation, and observe with what great reliability they do their work in this large and scattered plant. It is thought that a description, together with illustrations of some of the various apparatus employed in carrying out the great work will not be without interest, as although this plant is of a temporary nature, and intended to be dispensed with before the opening of the Exposition, it has been erected and carried out with the greatest care, and embraces the best and latest methods of construction. It represents, in short, a very perfect electrical power transmission plant, and one in which the conditions are of a somewhat peculiar nature by reason of the long distances between the apparatus, and because this apparatus is being continually moved from place to place wherever it may be required to do any particular kind of work. For this reason the plant had to be built with lines extending in such a manner as to enable the power to be furnished at any building and all parts of the grounds.

II.

The first points that strike the observer in looking over such a task as the one under consideration, are the advantages to be gained by using electricity. The principal machinery to be driven for the construction of the buildings, which are made of wood and covered with staff, giving them the appearance of massive marble structures, are saw-mills for cutting lumber, and hoists for raising the iron and steel trusses, girders and heavy beams. In addition to these machines, pulverizing machines for molding clay are required and planers for shaping lumber. The principal advantage of operating the saw-mills by electric motors is absolute safety from fire, which is of the very greatest importance, on account of the great quantity of inflammable material around the mills. When portable engines and boilers are used, in which the waste wood is burned as fuel, there is a great liability from flying sparks igniting the surrounding shavings and sawdust. In saw-mills, on a large scale, electric power is used with a very considerable saving in attendance, as it is furnished to the contractors at any hour of the day or night whenever they may require it. Another item is the great convenience gained when it is desired to start and stop the machinery at frequent short intervals. In a temporary plant of this kind this feature is exceedingly advantageous from many points of view. Supposing a case in which a contractor is

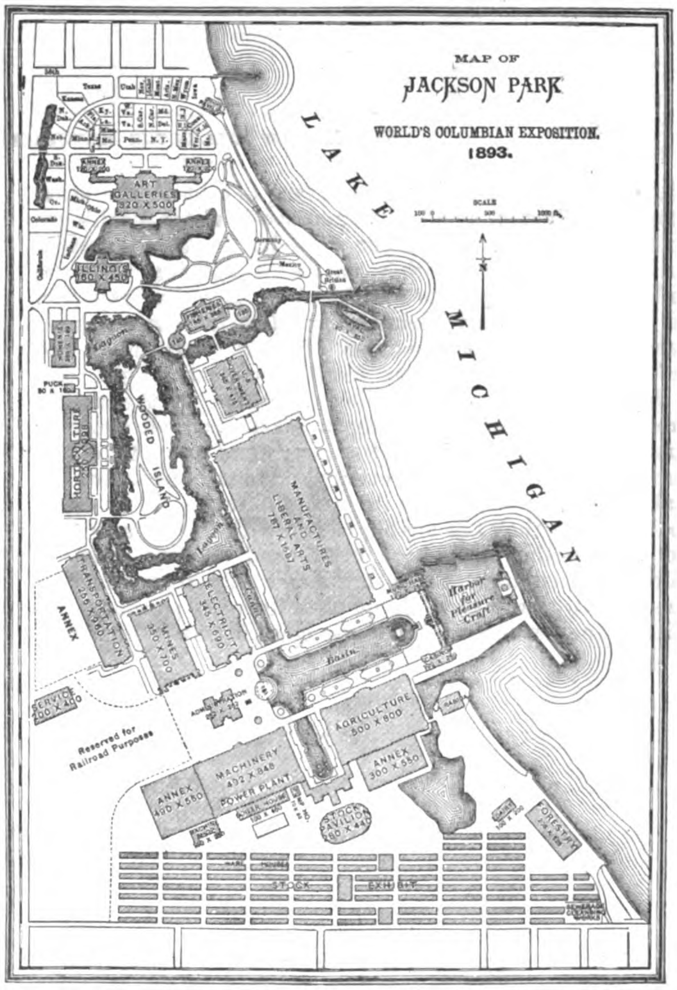


FIG 1.—THE AREA COVERED BY ELECTRICAL POWER PLANT, WORLD'S FAIR, CHICAGO.

running his saw-mill all day to-day and having cut out all the lumber he considers necessary, shuts down to-morrow, and then finds that while shut down he requires a few pieces of certain dimensions his motor is all ready for immediate service, and he is not compelled to keep his boiler fired up all the time. In operating saw-mills in general, there are always a number of tramways for conveying and hauling lumber and these can be more readily and better operated by electricity than any other means of power, and in most cases electric lighting is also used for the illumination of the mill and tramways, and a large saving in cost of operation is thereby effected, as all large and successful saw-mills are run day and night. The light given by electric illumination is so superior to other modes of lighting, that the lumber can be cut just as well by night as in the daytime, and in fact some enthusiastically electric sawyers have even had the hardihood to claim that they can detect imperfections in lumber more readily by electric light than by daylight. Where saw-mills are located in the neighborhood of waterfalls having a good head all the year round, as is very frequently the case, great advantages are attained by using electrical energy. Where wood-working establishments are situated in saw-mill towns, it is often the case that they are unable to run with their waste products, unless they use a high grade and efficient class of boilers and engines, which are necessarily expensive, and even in many cases they would then have to purchase additional fuel, whereas if they use electric power furnished from water, a very distinct saving in their running cost is effected.

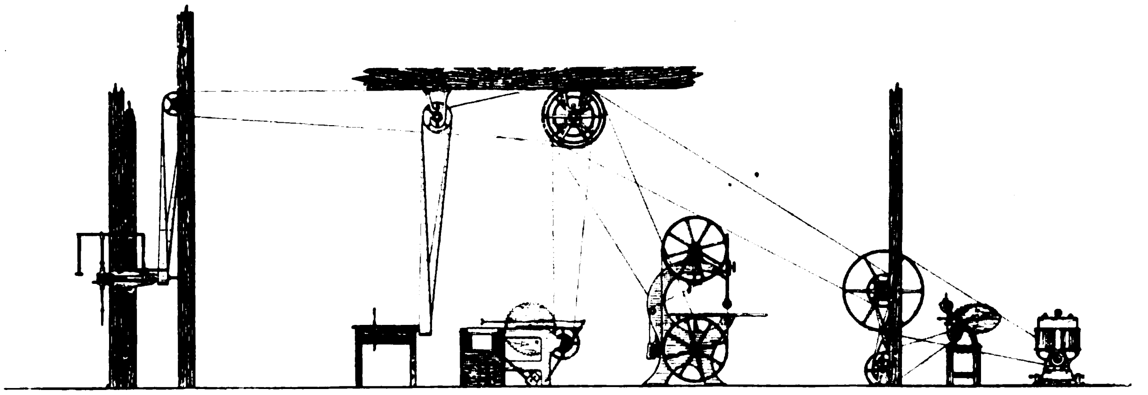


Fig. 2.—Saw Mill in the Manufactures and Liberal Arts Building.

The operation of hoists by means of electricity has some apparent advantages, and on the grounds of the Exposition the same features of safety and minimum amount of attendance as in the electrical operation of the saw-mills are very prominent. In this case particularly there is a great convenience and saving in fuel, as there is no necessity of keeping a boiler fired up all the time, and the economy is even considerably greater than in the case of the saw-mills, as a hoist is often left idle for several hours and then run possibly for but a few minutes, as the work is of a very intermittent character. Electric hoists are lighter and more compact, and therefore better adapted for transportation and uses in odd places, and they perform their work in a better and simpler manner, as they are more easily controlled.

III.

The prime consideration is the generating plant, furnishing the current for the motors; and its appurtenances of poles and wires for distributing the power. The plant at the Exposition grounds consists of two 100 K. W. compound-wound Edison generators similar to those used in their street railway work. These machines are run by two high speed engines belted direct, at such a speed as to give an average E. M. F. of 500 volts. The plant is thus divided into two distinct units, either one of which is capable of taking care of the entire load for a temporary period, reducing the chances of a total break-down to a minimum. It is a well-known fact that it is almost an impossibility to have all the motors running at once; and further, the machines are capable of taking care of a considerable overload for a short space of time. These machines are located in the "temporary" lighting station, which, by the way, does not have a very temporary look about it, it being built as solidly and laid out as neatly as many a permanent city station. The temporary pole line carrying the power conductors, makes a complete circuit of that portion of the grounds on which the Exposition buildings are located, so that the service can be tapped for use in any part of the buildings, or connections be made to any point in the grounds within a few hours at the most. This line, like the generator station, although only of a temporary nature, is of first-class construction, the best of material being used throughout, and a high insulation of the wires is maintained at all times, every circuit being subjected to constant rigid inspection and daily tests made of every part

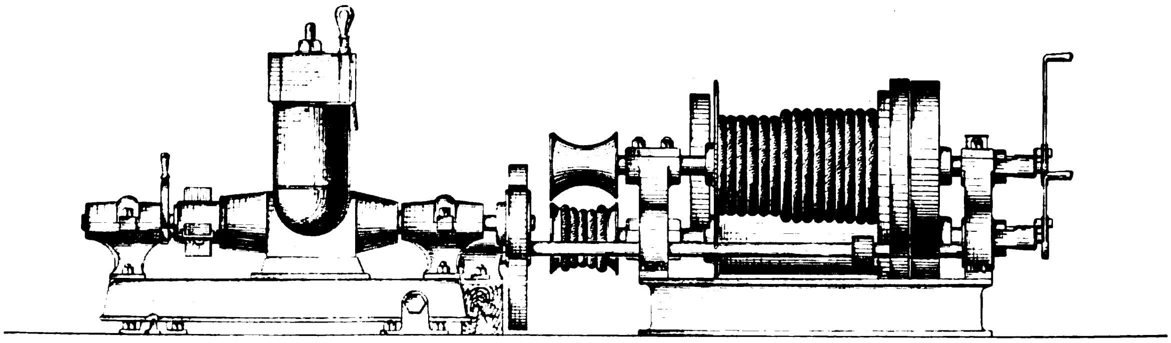


Fig. 3.—Electric Hoist in the Horticultural Building.

while in operation. The plan shown in our illustration, Fig. 1, is the latest one, of the various improvements in Jackson Park and shows the location of all the buildings, and their various dimensions and it can be seen at a glance where the building in which any of the machinery described, is being operated.

It may be stated here that no overhead wires will be used during the Exhibition, as a comprehensive system of underground subways is now being built and is well under way, in which the wires and cables for supplying all sections of the buildings and grounds with light and motive power will be placed.

IV.

In the description of the several machines run by electric power it has not been deemed necessary to enter into any very minute details of the construction, either of the motors or the saw mills and hoists, as most readers are familiar with the very simple mechanical working of these devices.

In Fig. 2 is shown one of the saw-mill plants which is in operation in the Manufactures and Liberal Arts Building, which it will be noticed is the largest structure of the Exposition, measuring 1,687 x 787 feet, and covering an area of more than thirty acres in a most conspicuous portion of the grounds, thus being the largest building for exhibition purposes ever constructed. This mill is run by a 12 K. W. Edison shunt-wound motor which is belted to a line shaft, the line shaft being belted to a counter-shaft which runs the saw sharpener, and also to another overhead counter-shaft running a band and cut-off saw, and by means of other counter-shafts, running a rip-saw and boring machine. This is a very compact and simple outfit, and like all the rest of the plant does its work reliably and well.

In the United States Government Building which is situated near the lake shore to the south of the main lagoon and is an exceedingly handsome and imposing structure, another saw-mill plant is at work. A 15 K. W. Edison shunt-wound motor is belted to a line shaft beneath the floor level, which carries pulleys belted to cut-off, rip-saw and boring machines. The leading architectural feature of this building is a central octagonal dome 120 feet in diameter and 150 feet high.

Another saw-mill plant, is in use in the Mines and Mining Building, in which it is interesting to note that the cantilever system as applied to roofs is used, and which is the only building, excepting the large domes, that has steel roof trusses. A 15 h. p. shunt-wound Sprague motor was doing the work here at the time of making the drawings, but a 6 K. W. Edison motor has now been substituted for it. The motor is belted to a counter-shaft carrying a pulley which runs a rip-saw and grindstone. A somewhat similar saw-mill plant is located in the "Horticultural Building." An 8½ K. W. Edison shunt-wound motor belted direct to a line shaft, running cut-off saw, grindstone and boring machine, and a rip-saw by means of a separate counter-shaft, is here to be seen at work. The "Horticultural Building" is also equipped with an electric hoist of which the accompanying cut, Fig. 3, gives a very complete idea. The motor, which is a 20 K. W. shunt-wound Edison, is mounted upon the same frame-work as the bed-plate of the hoist, and geared to it by means of a rawhide pinion on the motor shaft and a gear attached to the main shaft of the hoist. The bed-plate is made to receive a steam engine and boiler. This precaution was taken in order that this hoist could be used after finishing its work at the Exposition, in places where electric power was not obtainable. The hoist is of the ordinary double-drum form, with two winch heads. It is a very convenient machine, as it can raise two weights, or two parts of the same weight; while at the same time the winch heads can be used to drag material into position. The motor is run at a uniform speed, but the speed of the drums can be doubled by throwing in a back gear arrangement, and any further variations of speed desired can be obtained by means of the winch heads. This hoist is used for lifting the large trusses and purlins of the Horticultural dome, and is found to be equal to every demand upon it and can be controlled with the greatest ease.

Fig. 4 shows a similar electric hoist operated by a 20 K. W. Edison shunt-wound motor and which is in use in the Transportation Building, lifting the main trusses and purlins used in its construction. The hoist is mounted on the same base as the derrick, which is movable upon rollers in order to place it in any desired position. The motor is attached by a single set of gearing to the hoist in a similar manner to Fig. 3. This, together with the former cut, shows the details and construction of the hoist apparatus very clearly. This hoist has, since the date of writing, been removed to the Agricultural Building, where it is now in use.

The Transportation Building is also furnished with a saw-mill which is operated by a 12 K. W. Edison shunt-wound motor driving cut-off, rip, band saws and grindstone. The motor belts to a line shaft, which in turn runs the various mechanisms.

A large saw-mill plant, Fig. 5, is located in the Agricultural Building. A 20 h. p. Sprague motor is belted to an overhead line shaft which runs the boring machine, band saw and cut-off saw. From this line a counter-shaft running a rip-saw is driven.

V.

The Electricity Building is also equipped with a saw-mill plant. The dimensions of this building as given in the latest map are 349 x 680 feet, and a few further details may not be out of place here. The south front of the building is on the large court and the north towards the lagoon. The general plan of the building is a longitudinal nave 115 feet wide and 114 feet high, crossed in the middle by a transept of similar dimensions. The second story comprises a series of galleries connected across the nave by two bridges and accessible by four grand staircases. The exterior walls of the building are composed of a continuous Corinthian order of pilasters 42 feet high, supporting a full entablature, and resting upon a stylobate

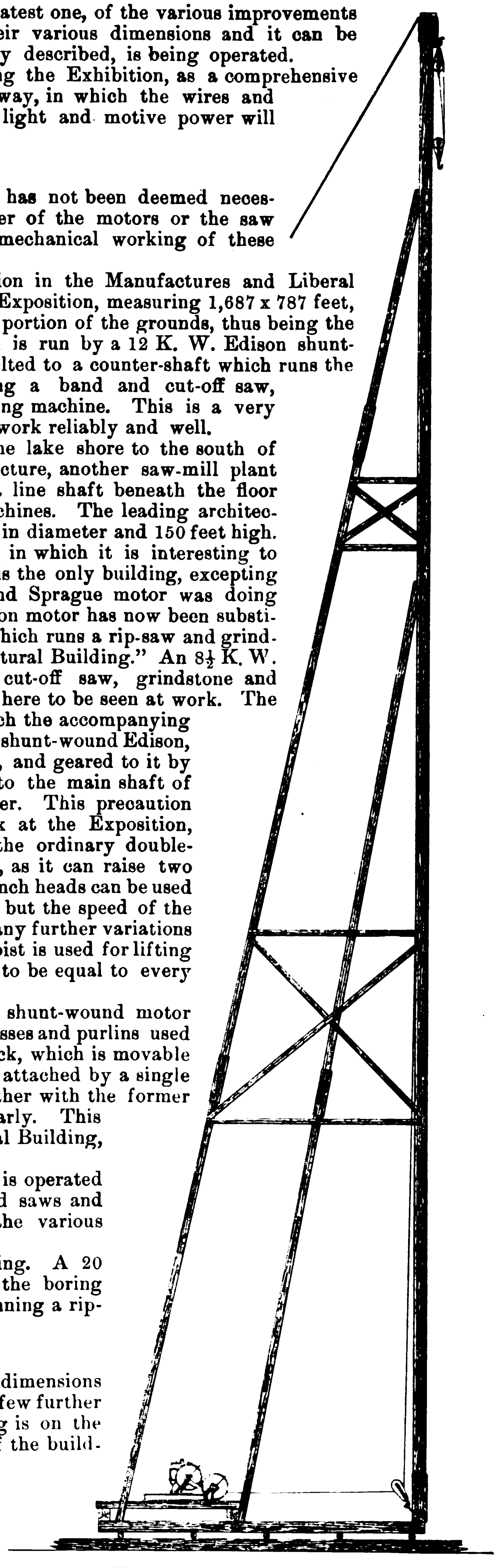


Fig. 4.—Hoist in the Transportation Building.

of 8 feet 6 inches. The total height of the walls from the grade outside is 68 feet 6 inches. Each of the four corners has a pavilion, above which rises a light open tower, 169 feet high. Intermediate between these corner pavilions and the central pavilions on the east and west sides, there is a subordinate pavilion bearing a low, square dome. In the design of this building the architects have endeavored to so devise its details and general outlines that an electrical illumination by night can be provided which in effect will be unequaled, even the flag-staffs, open porticos and towers being arranged with this end in view. The illustration Fig. 6 shows a plant which is run by a 12 K. W. Edison shunt-wound motor belted to a shaft from which run other belts to band and rip saws, gearing being used to run the cut-off saw.

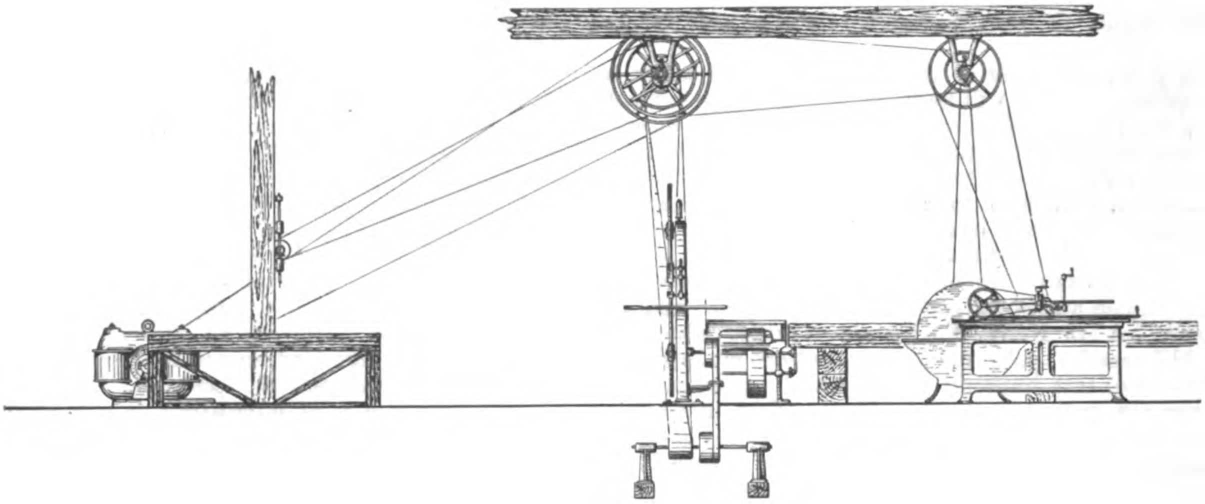


FIG. 5.—SAW MILL IN THE AGRICULTURAL BUILDING.

Fig. 7 illustrates an electrically operated automatic pulverizer made by Raymond Bros. This pulverizer is run by a 12 K. W. Edison shunt-wound motor which is belted direct, driving it at a speed of 1,200 r. p. m. This machine is used in molding clay for crushing purposes and other work of that class.

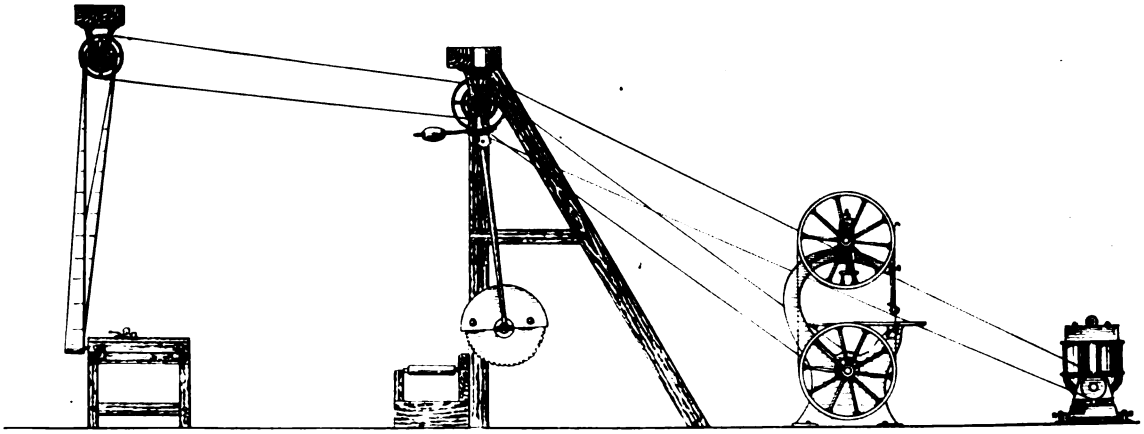


FIG. 6.—SAW MILL IN THE ELECTRICITY BUILDING.

In the Machinery Hall is placed a saw-mill as shown in Fig. 8. This is run by a 25 h. p. Sprague motor, which is belted to a shaft running beneath the floor from which driving belts run to a cut-off, rip-saw, boring machine and grindstone. Another saw-mill plant is situated in the Illinois State Building. An Edison 15 K. W. shunt-wound motor drives this mill, being belted to a line shaft which drives a rip and table cut-off saw, also running by means of two counter shafts a cross-cut saw. There has also been installed in this building a 6½ K. W. Edison Standard electric hoist which has recently been received. This is of the single-drum pattern and similar in every respect to their electric hoists of which so many are doing excellent work in all parts of the country.

VI.

In addition to the several plants shown in our illustrations, a saw-mill plant similar to the above has just been placed in the Fisheries Building, a 20 K. W. Edison motor operating a band, rip and cut-off saw. A 6½ K. W. electric motor operating a planer has also just been placed in the Women's Building.

All the motors running the various plants are operated by means of an ordinary starting switch and rheostat, and main line switches in series with each motor; approved fusible cut-out arrangements being used in every case.

Each motor is housed to protect it from dust, dirt, rain and accidental injury. The motors were furnished to the machines in accordance with the amount of work that the latter might be doing and not necessarily of a power equivalent to the full capacity of the mechanical plant; and changes in the motors have been occasionally made, as the work required to be performed by the mills, hoists, etc. has been changed. It may be mentioned that the charges made by the Exposition Company to the contractors for the power and use of the motors are based upon the average daily maximum load taken by instrument readings.

VII.

The results, as predicted by the electrical engineer, his assistant and the staff of the construction department, have proved to be eminently satisfactory, and the champions of the portable steam engine and boiler operation of saw-mills, hoists, etc., have lowered their flag in favor of the electric motor. The work done by the motors has also showed conclusively that they could be loaded largely in excess of the rated capacity momentarily without sparking, burn-outs or any injurious results.

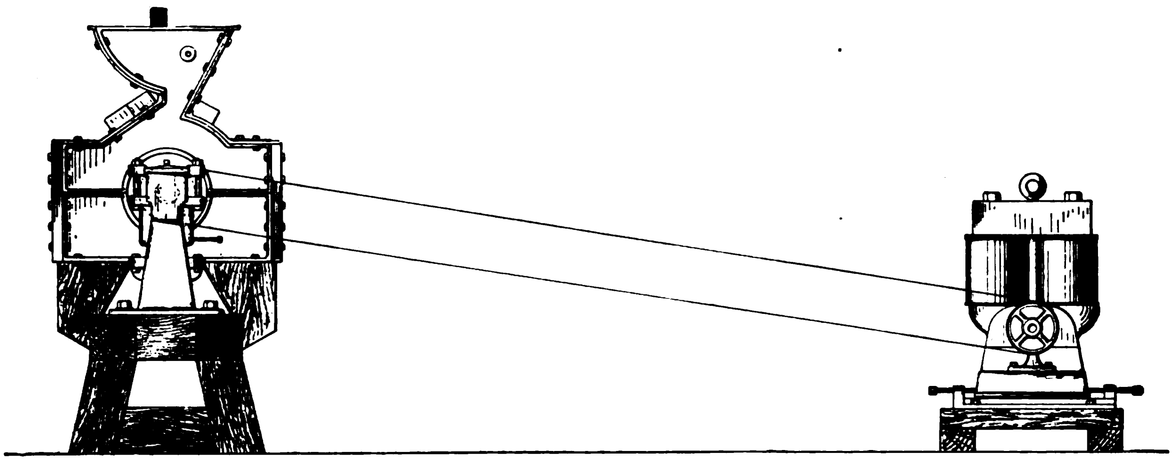


FIG. 7.—AUTOMATIC PULVERIZER, WORLD'S FAIR GROUNDS.

The entire plant is leased by the Exposition Co. from the Edison General Electric Co. and is to by returned by Jan. 1, 1893, in as good condition as received. This transmission is quite an important one, although temporary, on account of its magnitude, the long distances separating the various plants, and the necessity of having the power of easy access for tapping, at any point within the entire grounds, where it may be required. The motors cover a scattered territory about a mile north and south by about half a mile wide. The absolute freedom from accident or failure of any kind which the plant has enjoyed from the outset proves convincingly that this means of transmission is as reliable as, even if not more so, than any other known method.

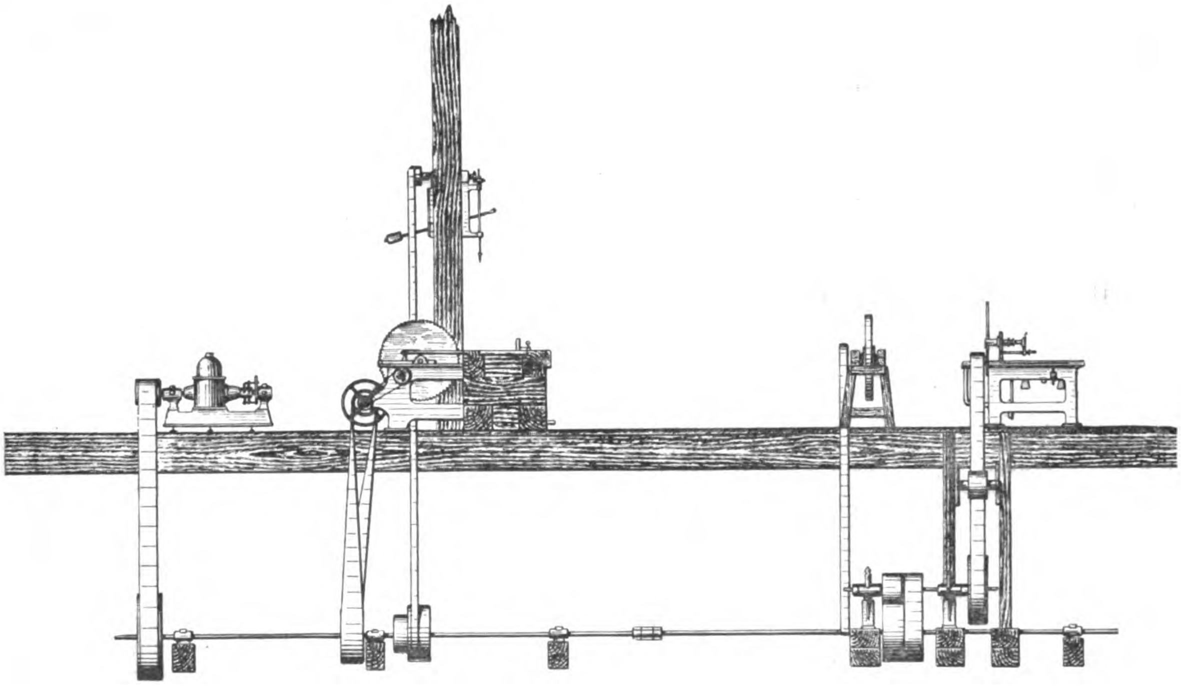


FIG. 8.—SAW MILL IN MACHINERY HALL.

It will be a pleasing thought to electrical engineers and those interested in the electrical industry both in our own country and from all parts of the world, when they visit the great Exposition in 1893, to remember that electricity was the power employed for raising these mighty structures.

RESISTANCE OF COBALT.

PROF. C. G. NOTT, in a paper to the Proceedings of the Royal Society of Edinburgh, comes to the conclusion experimentally that between the temperatures of 400° C. and 700° C., the resistance of a cobalt strip increases on an average at a rate nearly twice as great as the average rate of increase between 0° and 300° C. He also investigates the thermo-electric position of cobalt.

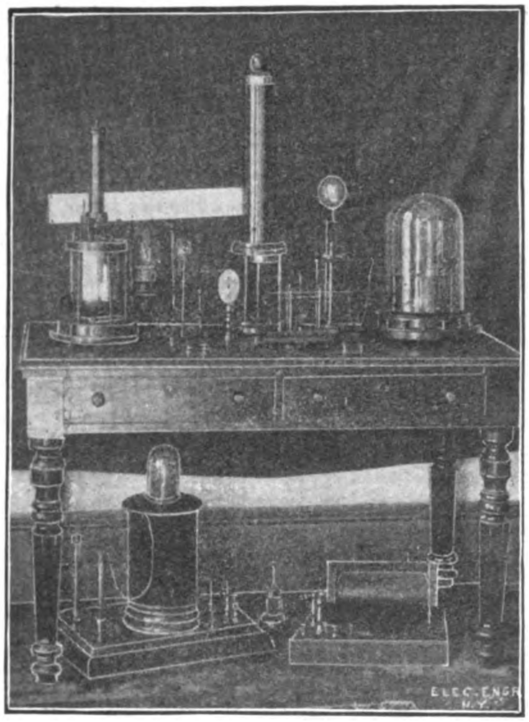
INSULATED ELECTRIC CONDUCTORS.[1]—II.

BY

James Bowstead Williams M.D.

CHAPTER II.

THE electrical testing apparatus consisted of a quadrant electrometer with its replenisher and gauge in a separate vessel; a lamp, lens, shield and scale; a coil giving five-inch sparks, and cell for operating it; a discharge key with a supporting arm for short wires fastened to its base; an upright cylindrical air condenser; and a battery of 24 cells. The greater portion of this apparatus is shown in the accompanying illustration of a group of instruments made by the writer. In the illustration accompanying the succeeding article, the same instruments, arranged for testing, will be shown in enlarged views, with reference letters added for convenience of description. The replenisher and gauge will be added to the group in this illustration and the air condenser omitted. When first constructed, the needle and mirror of the quadrant electrometer were suspended by a single cocoon fibre about eight inches long. The mirror, of the kind described by the writer in an article in the *Electrical World* of July 23, 1887, had a short magnetized needle cemented to the back, and the needle system was directed by a cylindrical magnet mounted on an adjustable swinging arm secured to the cover of the jar. This arrangement, although a very sensitive one, was soon altered, for reasons which will become apparent when describing the action of the instrument, the magnets and adjustable arm removed, and a bifilar suspension, with the necessary adjusting devices, substituted therefor. The quadrants are not mounted upon glass pillars, as in the Thomson electrometers, but are suspended from a circular plate of prepared material the insulation of which is not affected by any small amount of moisture which might be present in the jar. The back, quadrants are stationary, but the front ones are capable of adjustment from the outside. The insulation of the quadrants is so perfect that they will remain charged at potentials of 5,000 volts and upwards for hours without any perceptible leakage. Perfect insulation of the electrometer, and also of the discharge key and its supporting arm is absolutely necessary when the instrument is to be used for determining the comparative insulation resistances of insulated wires in lengths of one inch and upwards. The electrodes of the quadrants and of the needle and induction plate are similar to those of the Thomson instrument and have the same adjustments. The screen has a round hole bored through it, across which is stretched a fine black wire; this causes the spot of light which moves along the scale to appear as a bright disc with a perpendicular dark line or band (the image of the cross-wire) drawn across its centre.



GROUP OF TESTING APPARATUS.

The scale is divided into 300 equal divisions by lines $\frac{1}{20}$ of an inch apart. The spaces between the lines are wide enough to allow the image of the cross-wire to be easily seen when it is passing from one line to another along the scale. The battery (not shown) consisted of 24 zinc-copper cells secured in the containing case and at proper distances from each other by a filling or layer of paraffine. This layer was thick enough to insulate as well as isolate the cells from each other and from the bottom and sides of the case.

The discharge key resembles the ordinary form, as made in this country, with the exception of the trigger, the hook of which is more highly insulated than that of the keys in general use. On the base of the key is mounted a stout pillar about eight inches long to the top of which is secured a horizontal swinging arm. This arm carries two adjustable supports, each of which has a **U** shaped depression formed in the upper part, in which pieces of insulated wires are held while being tested. The pillar, arm, supports and set-screws are all made of hard rubber. The air condenser had but two concentric coatings. The outer one was formed of a brass tube and rested in a groove turned in a ring of insulating material. This ring was supported by three hard-rubber pillars and was highly insulated. The inner coating was a solid cylinder and was supported by a single hard-rubber pillar. All of the edges of the metal were rounded off and made smooth, so as to prevent any dissipation of the charge of the condenser. The replenisher and gauge will be described in the next article.

Digressing for a moment from the line of my subject I will now refer to a difficulty which doubtless has often been encountered by many who use electrical instruments for measuring high potential currents. I mean the surface leakage of hard-rubber pillars and supports. I found that, in order to prevent surface leakage on the exposed hard-rubber parts of my instruments, it was necessary to coat these parts with paraffine wax almost every time the instruments were used; as moisture, particles of dust and other light substances would invariably collect upon the surface of the hard rubber, along which leakage would take place. By "hard rubber" I mean those products commonly called Vulcanite and Ebonite. This material *should* be composed principally of pure india rubber and sulphur and vulcanized at a high temperature for several hours; but, as usually sold, it contains many ingredients which certainly do not increase its insulating properties. For instance, some manufacturers add a large quantity of lampblack (carbon) to the mixture of rubber and sulphur and, in addition to the lampblack, lead and zinc oxides, substances which are cheap and "weigh well," but all of which cause the specific resistance of the vulcanized product to be very much lower than that of *good* hard rubber. Other manufacturers add the dust obtained during the finishing and polishing of articles made of hard rubber to the mixture of rubber and sulphur; and as this dust is generally gathered off the floor it is very apt to contain particles of metal and also of the rouge powder which is used in polishing the manufactured articles.

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It is a common thing, while cutting into the hard-rubber rods and tubes on sale in the stores, to encounter pieces of metal and other foreign substances firmly embedded in the mass, proving, by their presence, that they were incorporated with the rubber and sulphur before vulcanization. Another adulterant of hard rubber and, it is to be feared, of rubber *insulating* compounds, is what is known as "recovered rubber." This substance can be obtained from rubber boots and shoes which have outlived their usefulness by cutting them into small pieces and melting the pieces over water (the fire being above), into which the melted material falls. This material is then well washed, dried, and dissolved in a suitable volatile solvent, and the solution allowed to stand until the insoluble substances settle to the bottom of the vessel. The solution is then decanted and the solvent distilled, condensed and retained for future use. The rubber thus "recovered" is worked on rolls for a few minutes, and is then ready for the market, where it is sold for about $10 a ton. Pure Para rubber, the only kind that should be used for insulating purposes, costs at least $1,500 a ton; and the relative values of this and the recovered rubber, for insulating purposes, may be assumed to be nearly in direct proportion to their market values.

After many tests of different qualities of hard rubber and substitutes for the same, the present writer found that nothing but the purest quality of this material could be used in the construction of testing apparatus similar to that described in this article, or of any other apparatus the efficient performance of which depends mainly upon the perfect insulation of the various parts thereof; and in no case could the quality of the material be determined except by actual tests. Furthermore, the writer has yet to find a substitute for hard rubber now on sale which has a specific insulation equal to that of good hard rubber, or which can be substituted for that material for insulating bodies charged to a potential of (say) 2,000 volts.[1]

Another trouble experienced in the use of hard rubber is due to the fact that there is always more or less free, *i. e.*, uncombined, sulphur present in this material. This sulphur forms with the moisture present in the atmosphere, acids, and there is therefore a film of acid upon the surface of all unprotected tubes and rods of hard rubber, which not only acts as a first-rate conductor for high potential currents, but gradually destroys the rubber itself. The film of acid also serves as a fixative for dust, etc., which come in contact with the surface of the rods and tubes. Brushing over the surfaces of such rods or rubbing them with a dry cloth does *not* remove minute foreign substances, but simply distributes the particles of dust, shreds of fibre, etc., into new positions upon the surface. The rubbing also electrifies the rubber, and thereby causes it to attract to, and retain against, its surface any light floating bodies in the immediate vicinity; and thus the source of surface leakage which the brushing or rubbing was intended to remove is increased.

By subjecting hard rubber to the following treatment the present writer has experienced no difficulty in insulating different parts of electrical testing and other apparatus. The tube which insulates the sliding electrode of one pair of quadrants of the electrometer will be used for illustration. The tested material is first formed into a tube of any suitable and desired shape, in a lathe, and the tube then washed in a solution of caustic soda in water, to remove any grease and dirt. After the tube has been thus washed, and before it is removed from the caustic solution, it is grasped by a pair of forceps and transferred to another vessel, and there rinsed with clean water until every trace of the soda is removed. This can be ascertained by testing from time to time, during the washing, with litmus or turmeric paper. The tube is finally cleansed by allowing distilled water to run over all of its surfaces for a few seconds, and then dried over a fire free from smoke. Under no circumstances should it be touched with the hand after its removal from the alkaline bath.

The tube is now ready for a coating of paraffine wax, the objects of which are (1) to protect the rubber from atmospheric moisture, and (2) to increase the surface insulation. The tube is supported in one hand by means of a piece of wood or metal (previously prepared) fitted into one end. A clean piece of the *best* quality of paraffine wax is taken in the other hand, held over a lamp until the wax begins to melt, and the melted wax allowed to drop upon the tube until a quantity sufficient to cover it has fallen thereon. The tube is then revolved over the lamp until the wax flows evenly upon its surface, forming a thin uniform layer which, when cold, firmly adheres to the tube. The inside of the tube is paraffined by holding it in a pair of forceps, dropping melted wax into the ends, and then distributing the wax upon the inner surface by means of a clean rod of metal heated over the lamp. Hard-rubber rods and pillars are paraffined in the same manner as the outside of tubes, the rods being supported by a rod of wood or metal fitted into a hole bored in one end.

A rod, 8 inches long and ½ inch in diameter, prepared for use in the manner above stated can be used to insulate bodies charged to a potential of about 10,000 volts provided that the rubber be of good quality. Great care must be taken to not overheat paraffine while applying it to supporting rods, tubes, etc., because if heated above 250° F. decomposition begins and its high specific resistance is diminished thereby. The layer of paraffine can be renewed without removing the insulating supports from apparatus by scraping it with a clean knife, or by passing a heated flat tool over every portion of the layer, which both isolates and insulates any foreign particles from each other and from the surface of the rubber.

If the ends of rods are made concave, *i. e.*, cup-shaped, in a lathe, such rods, when secured by screws to flat surfaces, will afford a much firmer support and be less liable to become loosened by jars and vibrations than if their ends were simply turned true in the lathe. The surface of hard rubber rods can be enlarged by corrugating the rods in a lathe, that is, by forming alternate elevations and depressions from one end of the rod to the other. Such rods, when in an upright position, afford better security against the formation of a continuous film of dirt on their surface than plain rods; because the hollow spaces are to a great extent protected by the ridges above them. But corrugated rods must be carefully watched and paraffined if perfect insulation is to be obtained by their use. It is obvious that ornaments on pillars when formed by a turning lathe, also increase the length of the surface of such pillars.

The surfaces of hard-rubber pillars, etc., may be renewed by rubbing them with clean glass or emery paper. The surface, thus renewed, will insulate as well as the original surface of the newly finished material if moisture from the fingers and particles of dirt have not been left upon the surface after the rubbing.

It is impossible to keep the hard-rubber parts of testing instruments too highly polished if the highest insulation resistance of such parts is required.

Hard rubber, when pure, contains no gritty particles, has a uniform color and consistency throughout the mass, and smooth shavings can be cut from it with a sharp knife. Still, the mere fact that the purchased material does possess these properties is not necessarily a proof of its purity; for oily products, and other substances, can be incorporated with the rubber and sulphur before vulcanization, and which will cause the vulcanized product to resemble good hard rubber but, at the same time, have a specific resistance much lower than that of the pure material.

As before stated, the only way by which we can *know* that we have pure hard rubber is by testing it. A good standard for comparison is pure paraffine wax, as the specific resistance of pure hard rubber is not much lower than that of the wax.

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[1] The writer would take this opportunity of requesting manufacturers of such substitutes to send thin pieces, measuring 2 x 4 inches or thereabouts, of their products, to his office, at No. 44 Broadway, N.Y. City, for private examination.

THE FORD-WASHBURN STORELECTRO CO.'S STORAGE BATTERY CAR.

While the overhead trolley system of operating street cars has continued to increase the number of its installations with rapidity unequaled in any other industry, the workers after the solution of the problem of doing away with the overhead network and carrying the energy upon the car itself, dispensing with conductors of all kinds, have manfully attacked the diseases of the early storage batteries. Mr. G. A. Ford and Mr. George Washburn, of Cleveland, have devoted time and money to the problem, and, after numerous experiments, have perfected and brought out a new form of storage battery and a complete system of electrical storage traction, which, they believe, combines all the requirements of a practical and commercial system. In view of the great importance that attaches to the subject, the subjoined details will be found of more than usual interest. While the trolley is all triumphant at the moment, there are many electrical engineers who look confidently for the ultimate victory of the storage car, and there are many places where without it electricity remains debarred.

In attacking the problem it was decided that a radical departure in the forms of storage battery was necessary to successfully cope with the difficulties and severity of street car service, and that the main features that must be provided in a commercial system were as follows: The cells must be capable of withstanding the heaviest discharges, even to dead short-circuit, without injury. Short-circuits must be impossible within the cells. The batteries must be durable, and require, practically, no attention; be cheap and of good efficiency. Buckling or falling out of active material must be impossible.

To fulfil these conditions and provide a commercial battery, it was determined in the first place to dispense entirely with plates, in the strict sense of the word, and employ conducting receptacles containing and in intimate connection with the active matter, the positive and negative elements of which should be separated by a porous low-resistance mechanical partition instead of space, as heretofore employed.

These form important and radical features of novelty in storage battery manufacture, and are the principal points in the Ford-Washburn cells, of which the following more detailed description will clearly show the method of construction. The dimensions of a 150 ampere-hour cell, as used for street car work, are 12 inches high by 4½ inches by 8 inches, weighing, complete with acid and rubber box, 40 lbs.

In the latest form there are five sets of elements, comprising four positives and five negatives, surrounding the former on all sides. The arrangement is exceedingly simple. An outer casing, made of specially prepared lead to withstand the action of the acid and deterioration, perforated with small holes so that the acid can percolate through but the active material cannot by any possibility get out, is formed into a rectangularly-shaped cup or receptacle, comprising, with its active material, a negative element. Inside this is placed a porous pot of special manufacture, which in turn contains active material surrounding and in intimate relation with a conducting medium of perforated lead, which is so constructed as to take care of the expansion and contraction of the active material during charge and discharge, and forms a positive element.

The negative elements are all connected together by a solid lead strip welded to the *bottom* of each receptacle—a new departure in accumulator work—and are also all touching one another and therefore in good electrical contact at numerous points, a result of course unattainable in a plate cell, as the plates are arranged alternately positive and negative. The positive elements are similarly connected but at the *top*. This method of connection is employed from the consideration that a more evenly distributed discharge is thus obtained and extra strength given to the battery. The positive elements are by this means entirely surrounded by the negative, and have a large surface of active material exposed to the electrolyte; and as the thickness of the porous partition is only ⅛ of an inch, the internal resistance is quite unappreciable. A short-circuit between the two is impossible as the porous pot is between them and extends a trifle above the receptacles at the top so that the positive and negative active material is at all times kept absolutely separate. The sets of elements are placed in hard-rubber boxes and for street railway work hermetically sealed and put in the car, as they require no inspection at frequent intervals and no attention except to replenish the acid when required on account of evaporation. This, however, as the air is kept from the interior of the cell, need only be done at long intervals.

An interesting experiment and one which is constantly made with any and all of these cells is to short-circuit them through an ammeter capable of reading up to 300 or 400 amperes and discharge them completely at the highest possible rate, which instead of injuring the cells at all, does them good, according to the inventor. The heavy discharge the cells give under this severe test shows their low internal resistance.

The appended table shows a test of a cell on a resistance giving volts and amperes taken every 15 minutes during a period of six hours. At the expiration of this time the cell was not by any means entirely discharged and if allowed to rest for a time the voltage would have risen again to very nearly normal. There is no necessity of leaving in any initial charge as these batteries can be entirely emptied without any injurious effects.

150 A. H. Cell.

V.	Am.	Time.	V.	Am.	Time.
2.3	25	10:15	1.9	24	1:45
2.1	25	10:30	1 9	23½	2:00
2.1	25	10:45	1.9	23	2:15
2.1	25	11:00	1.8	22	2:30
2.1	25	11:15	1.7	21	2:45
2.1	25	11:30	1.6	20	3:00
2.1	25	11:45	1.5	18	3:15
2.1	25	12:00	1.4	17	3:30
2.1	25	12:15	1.2	16	3:45
2.1	25	12:30	1.2	15	4:00
2.1	25	12:45	1.2	14	4:15
2.1	25	1:00			
2.0	25	1:15			
2.0	25	1:30			

Readings from one cell.

The Ford-Washburn Storelectro Company have equipped the fine car shown in the accompanying illustration complete with their system of storage battery and motor and have named it "The Ideal." This car has been run all over the several lines in Cleveland up grades and around curves and under all kinds of conditions such as exceedingly heavy loads, drawing trail cars, etc., and has showed itself perfectly satisfactory, it is said, and capable of performing any work upon which it was put. The car is 28 feet long over all and 21 feet inside, and was built by the Brill Company, of Philadelphia, specially for the purpose. It is exceedingly attractive, painted white and gold, fitted with French plate-glass windows, hard fancy wood interior finish, and handsomely upholstered and equipped with ratchet brakes and all the latest improvements. Under the seats are placed the batteries, in three rows of 30 cells each on either side, making 180 in all. By means of a a mechanical device all the batteries can be quickly run out at either end of the car and another set run in if desired. It takes about three minutes to effect the change. The weight of the cells complete is 7,200 lbs. The car body is mounted on a modified Tripp truck with special extension springs and having a wheel base of seven feet and 33-inch wheels.

It is equipped with a single 35 h. p. Ford-Washburn motor capable of working up to 40 h. p. for an indefinite period and weighing about 2,000 pounds. The armature of the motor is lengthways of the car and is fitted at the end of its shaft with a pinion gearing with an intermediate gear on a shaft passing between two of the field coils and suitably supported in bearings. At each end of this shaft is a bevel pinion running a bevel gear on each axle thus transmitting the power positively to both axles.

The motor is series wound, the field being in sections arranged for commutating for obtaining variable speed. There are four coils each divided into three sections, the field having four magnet cores and being of the consequent pole type with yokes at each end and made entirely of best quality of wrought iron. The Ford-Washburn ventilated armature similar to those of their stationary motors is employed, and a modified Siemens winding is used.

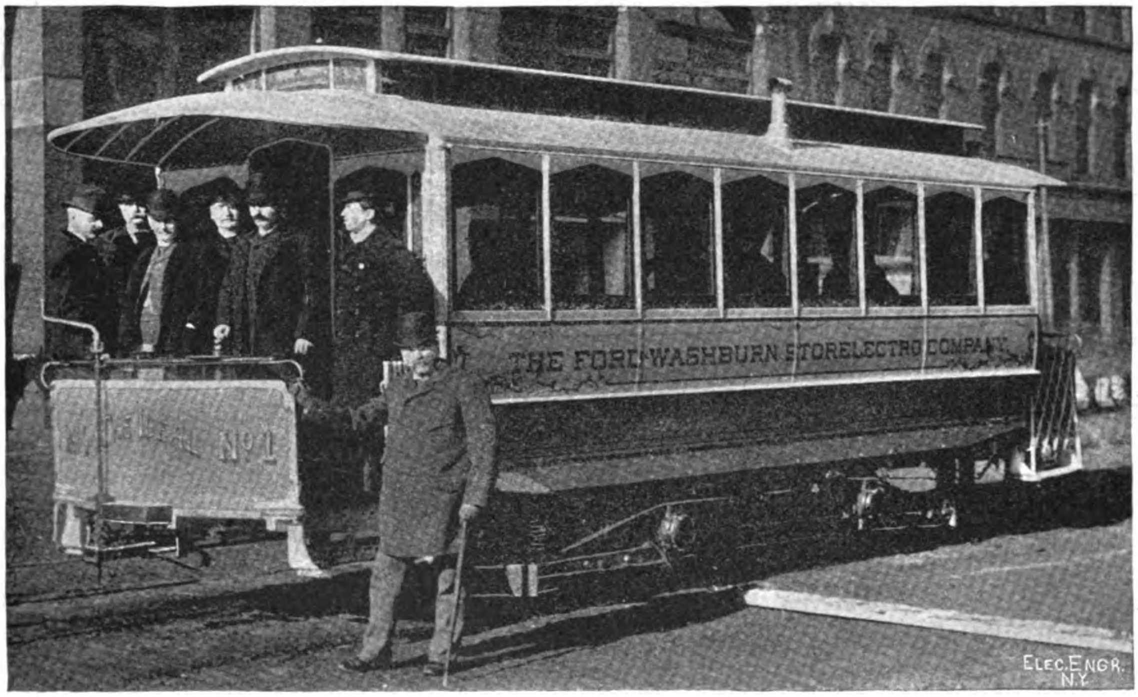
On this car there are two variable speed arrangements, the first dependent on the means of coupling the batteries by which three speeds are obtained; with four sets in multiple of 45 cells each, giving 90 volts; with two sets in multiple of 90 cells each, giving 180 volts and with the whole 180 cells in series, giving 360 volts.

The second consists in commutating the field by which four other changes in speed can be obtained; first, all coils in series; second, one section of each field coil cut-out; third, two sections cut-out and fourth, all in multiple. The arrangement of the coils and sections is such that the magnetization of the magnet cores is at any time similar, with respect to one another. By employing the two methods together, wide variations in speed can be got. The various changes are carried out by means of a switch lever provided with special reversing switch at either end of the car. A further special switch for instantaneously shutting off the current is placed at each end of the car and connects between batteries and motor, to be used in cases of emergency.

In starting the car, the field coils are all cut in with four sets of the cells in multiple taking about 15 amperes of current. With the highest speed at which the car ordinarily runs, from 15 to 18 miles an hour on a good level track, about 20 amperes are absorbed; on heavy grades from 35 to 40 amperes is about the maximum. It would seem from the severe tests to which this car has been subjected and the small attention it requires that this system is likely to be largely used and there appears to be no reason why the batteries, which are the important factor in work of this kind, and in this case are of so remarkably simple and effective construction, should not prove to have a singularly long life, even on the severe strain of street railway service. It is a noteworthy fact that their renewal is of no costly nature.

On a trip made early this month over the Woodland Avenue and West Side and East Cleveland Street Railway Companies' lines of 16 miles with 35 passengers, the average current absorbed was 20 amperes at 350 volts. Three and three-tenths miles were run in 12 minutes. On the route named there are 23 sharp curves and 10 grades ranging from two to five per cent.

The writer has had the pleasure of examining the storage battery used, in various processes of manufacture, and inspecting the car and its equipment, and taking several extended trips over some of the lines both of the overhead and horse car systems, and noting the ammeter and voltmeter readings on the car while in actual service of starting, climbing grades, rounding curves, and so forth; and the results achieved are certainly very encouraging.



Storage Battery Car of the Ford-Washburn Storelectro Company.

AN AUTOMATIC POSTAL CALL-BOX.

A very ingenious automatic machine has been established near the letter box at Charing Cross Station, London, for the collection of letters to be forwarded by the Post Office Express Service. It is in electrical connection with the Postal Telegraph Office opposite the station. By dropping a penny into the slot, and pulling out the slide, a brown-colored envelope is delivered. This envelope contains another envelope and a card. The communication is intended to be written on the card, which is then enclosed in the white envelope, and this, with the fees for delivery, which have been fixed at three pence per mile, is re-enclosed in the outer envelope, and deposited in the box behind the flap, which bears the printed instructions. The act of withdrawing the slide sends the call signal to the telegraph office, and a messenger is at once dispatched to collect the special letters.

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It is better to be aware, or even to suspect we are wrong, than to be unconsciously or easily led to accept an error as right.—Faraday.

THE GROUNDING OF THE NEUTRAL IN THE THREE-WIRE SYSTEM.

IT has been for some years past the general practice among companies operating low tension three-wire circuits, more particularly among the various Edison illuminating companies in the country, to ground the neutral. This practice was introduced in a few stations as an experimental protection against lightning, and for a long time met with no opposition on the part of the underwriters, but it would appear that a recent fire in New York has brought forward prominently the question of the possible dangers involved in this practice. The New York Board of Fire Underwriters, at their last meeting, went even so far as to pass a resolution requiring the electric companies to remove all such grounds now existing on their circuits before October 1, 1892, and to make regular weekly reports of the tests of their circuits as called for in the requirements of the Board, failing in which the superintendent of the Survey Department is directed to decline to grant certificates. As this question is one involving very large interests it may be well to discuss it in order to bring out some salient features with regard to the practice of grounding the neutral, which are not generally understood.

Before proceeding, it may be well to state that the grounding of the neutral is no essential part of the three-wire system, and was not even considered desirable for several years after a number of such systems were constructed, and is now only used as an emergency expedient. It must be generally admitted that the absolute insulation of all the sides of the three-wire system, if it could be practically accomplished, is the most complete safeguard against dangerous leakage, and should be followed wherever the circumstances permit of it; or, to put it in other words, if such a system can be kept free from ground permanently the neutral wire need not be, and ought not to be grounded. Again, if a thoroughly insulated system be so constituted that a ground can be at once located and a remedy speedily applied, it would also be preferable to maintain the neutral insulated. But those who argue absolutely for the insulation of the neutral wire seem to leave out of account the fact that the conditions here assumed are more ideal than real. If we take, for example, the case of New York City, in which the Edison Electric Illuminating Company has over seven hundred and fifty miles of underground conductors directly connected to many thousands of lamps, and that these conductors are subject to many disturbances, both below the streets and within the interior of houses, that lamp sockets are frequent sources of grounds, etc., it will not be difficult to conceive that the maintenance of high insulation on such a system is a practical impossibility, and that with no other than a low tension source of energy could such a system be operated at all. We might go farther and say that the normal condition of such a system is a grounded one, in spite of all precautions that can be taken.

This being the case, the argument of those in favor of insulating the neutral would hardly seem to apply, while, on the contrary, those who argue in favor of the grounding of the neutral insist that fire risk is reduced; for, if a ground on the neutral wire in a building occurs it will be in no danger, while if on one of the other conductors it would blow the safety fuse and do all the damage of which it was capable, at once. On the other hand, if the neutral be insulated the fuse would not be blown till the appearance of another ground on the opposite side of the system, and this might occur during the absence of the occupants of the premises. It is also argued, and we think rightly, that the grounding of the neutral reduces the harmful pressure (that is, the pressure to earth) to 110 volts although the total difference of tension employed between the two outside wires is 220. The opponents of the grounding of the neutral insist that the insulation of the neutral ought to be maintained, but as grounds would of necessity occur and require time to locate and would necessitate the obtaining of permits to dig up stone-bound or asphalted streets, etc., it must be evident that such a rule would work enormous hardships on large companies. The insistence also on the rule requiring insulation tests of such a ramified system operating at low tension practically means the complete cutting off of the tested section while instruments were to be applied at frequent intervals, a step which we think will hardly be insisted upon as it would simply render the entire plant unreliable and hence prove a much greater difficulty than that which it is intended to forestall. It would be analogous to asking the gas companies to make periodical tests of their pipes under streets and to report their leakage. It is true that a leakage in the gas main brings no additional strain on the gas pipe in a building as is the case in the electric system, but as is shown above, a ground on either the positive or the negative conductor inside the building is at once made manifest when the neutral is permanently or periodically grounded, by the blowing of the fuse. While, of course, no reduction has ever been made in the amount of copper used in the construction of any Edison three-wire system because of the adoption of this expedient, the earth may nevertheless under certain conditions, reinforce the neutral no matter how large its cross-section may be, and thus aid in tiding over a sudden overload of one side of the system.

Besides the reduced fire risk claimed for the grounded neutral, the advocates of the latter point to the fact that it affords protection against lightning, particularly at the station and at the ends of extreme conductors of the system. Again it is of value as a means of keeping the corresponding middle conductors of two neighboring three-wire systems (usually operated separately) at the same potential, so that if it becomes necessary in an emergency to interconnect their conductors, either through their central stations or elsewhere, they can be so connected without any disturbance in their operation or danger to the apparatus. But perhaps the best proof of the value of the grounded neutral is the fact, established by experience, that whereever the neutral has been grounded, the "troubles" ont he circuits have been greatly reduced.

It is also pertinent to state that the action of the New York Board of Fire Underwriters in this matter is not in accord with the "National Code" adopted by the National Electro-Insurance Bureau, in August of last year, in which we find the following rule:

> In three-wire or other compensating systems, the intermediate conductor may be permanently connected to earth, provided facilities are furnished for automatically testing the insulation of the positive and negative conductors.

This Code is in force in about fifteen or eighteen States in the West and it now seems probable that it will be adopted at an early day by the Southern States and those on the Pacific coast. Nor must the fact be lost sight of, that in New England, where the most painstaking and intelligent inspections have been made for the past six years, the inspectors have been disposed to approve the grounding of the neutral, Capt. Brophy, among others, being, we believe, in favor of this practice.

While this controversy is still going on in this country it may not be out of place to draw attention to a similar case abroad which involves questions of as great, if not greater, technical and commercial importance. Our readers will recall the fact that Mr. Ferranti transmits alternating current at 10,000 volts from the station at Deptford into London, a distance of five miles, and employs for this purpose a concentric conductor. When Mr. Ferranti broached his plan of grounding the outer conductor in order to obtain immunity from dangerous shocks, he was met by much the same opposition as is now being manifested here, but after a full and complete argument of the case on both sides, the London Board of Trade gave its consent to the practice which is in vogue at the present time. If the New York Board of Fire Underwriters are looking for a precedent they would here have one of no little importance; and a calm survey of the situation with all the testimony for and against the practice should be taken before the intended revocation of certificates is effected. We understand that the local Edison Company if compelled, will take off the ground from their neutral, thus putting the responsibility for the change upon the underwriters.

THE TROLLEY FOR PHILADELPHIA.

LAST week, the Railroad Committee of Councils in Philadelphia decided by a vote of 14 to 4 to report favorably to Councils the ordinance granting permission to the Traction and People's lines to use the trolley system along certain streets. This looks as though Philadelphia will soon be in line with the rest of the country in the adoption of electric locomotion.

The rapidity of the introduction of the overhead trolley system has been extraordinary, and can only be accounted for on the supposition that it meets and fills one of the greatest wants of modern American communities. Of the 16 cities of the United States having over 200,000 inhabitants, 14, or 87 per cent., are equipped with electric roads. Of the 42 cities having between 50,000 and 200,000 inhabitants, 41, or 97½ per cent., have electric roads. Of the remaining 391 American cities that have a population over 8,000 we do not know of a score that have not electric roads or serious plans for establishing one.

These figures are certainly eloquent, and are among the most convincing arguments that an advocate for electric traction can present. They show that only two large cities, namely, Philadelphia and New Orleans, and only one relatively small city, New Haven, remain without an electric road; and all three, we believe, will soon be included, if present plans are carried through. The triumph of the system is wonderful, but not less wonderful is the fact that the apparatus that has already assisted in the locomotion of passengers equivalent to the population of the globe, but has not injured a single soul, should be ignorantly characterized by medieval journalists as "the deadly trolley."

It seems to us that this very rapidity of introduction of the trolley should encourage those who are working to make storage battery traction a commercial and economical success; and we are glad to note that the work in the storage field is kept up, with ever increasing promise of ultimate success. One of the articles in our current issue tells of some remarkable recent work in Cleveland.

Non-Arcing Metals.

THE early days of the telegraph did much to stimulate inventive genius to devise means for protecting the lines and apparatus from lightning, and with the coming of the telephone and the electric light came additional devices, based on various phenomena. Much of the energy of recent years in this direction has been devoted to the avoidance in such apparatus of all electro-magnetic coils which might impede the discharge of the lines to earth. The record of the work done in this direction by Mr. Alexander J. Wurts, as given in his Institute paper, in another column, is an excellent résumé of labors in a particular line, and the results to which they have led Mr. Wurts are of the greatest practical value. He shows in effect that for alternating currents, at least, we are placed in possession of materials for the practical extinction of arcs, and it would be strange if the discovery here made should not be applied to a large number of electrical devices in which destructive arcs are now liable to occur. The discovery is unquestionably one of the highest practical importance.

HOW ELECTRICAL COMPANIES MAY ENHANCE THEIR REVENUES WITHOUT INCREASING RATES.

BY

D H Babcock

APPARENTLY many of the electrical companies are not making any money, and as a consequence are not paying dividends upon their capitalization. In the rapid development of these enterprises the companies, as well as the general public, have underestimated the cost of producing the electric current which so brilliantly illumines our streets and buildings.

In an able paper read before the recent Electric Light Convention, in Buffalo, the Hon. Erastus Wiman makes an interesting presentation of this condition of things, and the causes that have led thereto. In the first place, the supplanting of a long-established system of lighting, even to a degree, could not be accomplished without a struggle. The competition between electricity and gas would naturally reduce the price of gas to consumers, which would influence in the same direction the rate for electricity. In the enthusiasm of this rapid development, the promoters have underestimated the cost of producing the electric current, and have not demanded that increase in price which a superior article should claim by right over an inferior in all markets.

An electric lighting plant is a complicated and expensive investment, subject to loss and depreciation. We have, first, the boilers as the foundation of the work to be done; second, engines of high efficiency to develop the necessary power; third, the generators of the current to be distributed; and fourth, the circuit of wires, over which the product is to reach customers.

In the early stages of such an enterprise, the bookkeeping may show a profit in operating, but afterward, the depreciation, the cost of repairs, and the substitution of new machinery is apt to place the balance on the reverse side of the ledger. As Mr. Wiman says: "One misfortune has been in electric lighting that a large investment has been available for only a short time. All day long, when other works, by rental or by active employment, were earning money, electric light plants have been compelled to stand idle. Even gas companies spend the whole day making gas, accumulating in their reservoirs for distribution during the night. Electric light plants, however, are compelled to manufacture and distribute at one and the same time."

An enterprise of such merit, and a commodity in such demand by the public, will not be allowed to fall into disuse; either the companies will increase the rate to customers, more nearly to correspond to the cost of production, or means will be found to supplement present rates by more economical methods, or rendering available forces or material now wasted through neglect or imperfect information. In support of this last idea, it may be stated that the steam at the station, after passing the engines, still has a value for heating, and may be made an item of vast importance, as can be shown in actual work. In all non-condensing engines, after the steam has done its work, it is calculated that nearly nine-tenths is still available for heating. This may then be termed a by-product.

There are many branches of manufacture, which might be named, whose profits come mainly from the utilization of these by-products. They are legitimate sources of revenue, and a neglect to profit from them would be considered wasteful to the last degree.

How can this by-product of exhaust steam be made to profit the owners of stations who manufacture the electric current?

Simply by laying properly constructed underground mains from the station, out through the streets of a city, where it may be distributed to houses, stores, offices, churches and public buildings. Heat is quite as indispensable as light in the economy of affairs. A temporary suspension of light would not endanger health and life, but it would be impossible to live in health for a day in our houses without heat artificially supplied during the inclemency of our winters. And no medium of heating is so popular, or being adopted to such an extent, as is steam. Another reason which recommends this practice to the managers of electrical stations is, that during eight or nine months of the year it keeps the labor at the station constantly occupied. The boiler plant is in active operation during every hour of the day. Interest on any investment counts constantly against earnings. If the plant is idle half of the time it is at a disadvantage. Here is a way to turn waste material into money and to keep men and plant from rusting in idleness. During lighting hours heating is supplied from exhaust, which costs nothing; during the remainder of the time live steam takes its place. There is little or no increase in office expense on account of this added business.

I have in mind an electric plant in a town of less than 20,000 inhabitants from which the exhaust steam is used in the way indicated. The power station contains three boilers of 100 h. p. each, and one boiler of 150 h. p. The company has constructed 4½ miles of electric railway, which is run 18 hours out of the 24. It also does a large amount of lighting, and this part of the plant is in use 12 to 14 hours per day, so that in this case some power is required throughout the entire day and night. To circulate its exhaust steam the company laid about 2½ miles of underground steam mains, composed of 10, 8, 6, 5 and 4-inch pipes. In this pipe a steam pressure of from 12 to 15 lbs. is carried. This produces a back pressure on the engines, which is overcome by increasing the boiler pressure to that extent. This condition does not embarass the action of the engines in the least. This steam plant is now being operated the third season. The first year the company had 36 consumers, the second year 69, and at present it is carrying 138 consumers. All of the churches located on the lines, school houses, many residences and public buildings have embraced the opportunity to relieve themselves from dust, gas, and smoke and the storage of coal. The Government Building is heated for $450 a season. Residences pay from $90 to $140 each. The 138 consumers on an average probably pay more than $100 each. Meters are used, and each customer pays for the amount of steam consumed.

In mild weather the heating is all done with the exhaust from the station; during a cold snap some live steam is taken from the boilers by an automatic device, which supplies live steam when needed, and closes when the exhaust is sufficient to supply the demand for heat. It is believed that the net earnings from this heating portion of the plant will pay 6 per cent. upon an investment of $150,000, the investment for steam mains being less than one-fourth of this sum.

The business of this company is now in a highly prosperous condition; made so, to a very great extent, by its adoption of heating by exhaust steam, which otherwise would be turned into the open air and lost.

I have mentioned the case of this company to show what may be done by many other electric companies to aid in placing them on a prosperous working basis. Other plants are already working in this way, and I think the plan is bound to receive quite general attention.

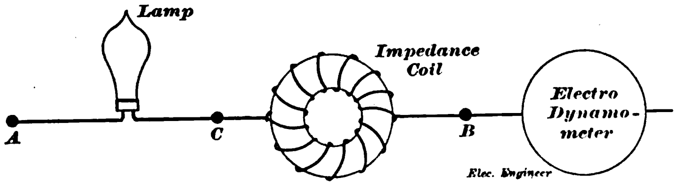
THE EFFICIENCY OF THE RIES REGULATING SOCKET.

BY

Henry Stott

THE following test of the Ries socket for varying the candle power of lamps supplied with alternating currents, was made with a view of determining the efficiency of the device and the writer now publishes the result in the hope that it will prove a useful supplement to the interesting article by Mr. Hammer in the March 9 issue of THE ELECTRICAL ENGINEER.

The socket tested was marked "50 volts, 25 c. p.," but as no 25 c. p. lamps were at hand a 16 c. p. was used and from the fact that, when the switch was on the last step, putting all the coils in circuit, the filament only gave a dull red glow of about a quarter of a candle power, it seemed quite well suited to this lamp.



The method of carrying out the test was one described by Messrs. Ayrton and Sumpner, with a slight modification to suit the case, the rationale of which is briefly as follows, referring to the accompanying diagram:

Let V_1 = Difference of potential between points A and B.
" V_2 = " " " " A and C.
" V_3 = " " " " B and C.
" r = Resistance of lamp.

The watts expended in coil $= \dfrac{V_1^2 - V_2^2 - V_3^2}{2\,r}$.

As the resistance of the lamp was a variable, an ammeter on the dynamometer principle was inserted, and the value $\dfrac{V_2}{a}$ substituted for r, a being the current measured in amperes.

The formula then becomes $W = \dfrac{V_1^2 - V_2^2 - V_3^2}{\dfrac{2\,V_2}{a}}$

$$= a\,\frac{(V_1^2 - V_2^2 - V_3^2)}{2\,V_2}.$$

All readings were taken simultaneously, the volts being read on the Weston type of voltmeter by simply releasing the spring, which stops the motion of the needle, at the same moment that the ammeter was read, and the reading noted before again releasing the needle. The ohmic resistance of the coils was determined immediately after the test by the ordinary bridge method. The paradox of the sum of two E. M. F.'s being greater than the E. M. F. supplied is well illustrated in the table given, as in one case it exceeds the E. M. F. on the mains by 13.5 volts. The accompanying table gives the results of the test and shows the efficiency of the socket at various degrees of incandescence of the lamp.

No. of contact on switch.	Impressed E. M. F. (V)	Volts between lamp terminals (V_1)	Volts on coils in circuit. (V_3)	Amperes.	Resistance of lamp.	Resistance of coils.	Apparent watts in lamp.	Apparent watts in coils.	Apparent total watts.	True watts in lamp.	Total true watts.	Ohmic loss in coils.	Inductive loss, hysteresis, etc.	Total watts lost in coil.	Efficiency in %, or ratio of total watts used to watts absorbed by lamp.
0	51.25	51.25	0.00	1.146	44.7	0.00	58.8	0.0	58.8	58.8	58.8	0.00	0.00	0.00	100
1	51.00	46.50	16.50	1.048	44.4	1.41	48.7	17.3	66.0	48.7	50.6	1.48	.42	1.90	96.2
2	52.50	42.50	23.50	.940	45.2	1.86	40.0	22.1	62.1	40.0	44.4	1.75	2.65	4.40	90.1
3	52.00	35.50	29.50	.818	43.4	2.50	29.0	24.1	53.1	29.0	35.6	2.05	4.55	6.60	81.5
4	52.00	30.00	35.00	.676	44.4	3.19	20.3	23.7	44.0	20.3	26.8	2.15	4.35	6.50	75.7
5	52.50	24.00	41.50	.552	43.5	4.06	13.2	23.0	36.2	13.2	18.5	2.24	2.96	5.20	71.9
6	53.00	17.50	45.50	.390	44.8	5.27	6.8	17.7	24.5	6.8	11.6	2.05	2.75	4.80	58.6

THE RELATIVE ECONOMY OF HIGH AND LOW SPEED ENGINES IN ELECTRIC RAILWAY WORK.

BY

Lemuel Wm. Serrell.

MR. WASON'S tests on the use of high and slow speed engines for electric railway work, as given in the last number of THE ELECTRICAL ENGINEER, are apt to be somewhat misleading.

By looking at the results of these tests there seems to be no great difference in the economy of the high and slow speed engines. But by looking at the last line the average horse power per car was 6.86 h. p. with the high-speed engines and 7.59 h. p. with the slow-speed engines, showing that the cars carried more people during the slow-speed engine test; that is, each car took 10.6 per cent. more power to run it.

The number of pounds of coal burned per car mile run are, respectively, 6.57 lbs. and 6.38 lbs., and as the slow-speed engines did 10.6 per cent. more work than the high-speed engines, on the basis of the same amount of work each, the slow-speed engines only took 5.7 lbs. of coal per car mile run, or 13 per cent. less than the high-speed engines. That the view here taken is correct is proved by taking the water evaporation and the h. p. hours and reducing to the number of pounds per h. p. per hour; we then find that the slow-speed engines took just 13 per cent. less steam than the high-speed engines per car mile run.

There is no question in my mind about the economy of slow-speed engines for all classes of electric work. I have, indeed, redesigned some electric light stations so that a saving of 50 per cent. in their fuel bills could be accomplished.

HIGH POTENTIAL TRANSMISSION.

BY

Elihu Thomson

THE electrical engineer, when he has before him the problem of conveying electrical energy through comparatively great distances, without excessive loss and without excessive amounts of copper in the conductors, is compelled to consider the use of high potentials. Of course, potentials are high or low relatively to others taken as standards, but by a sort of common consent it has come to be regarded that, when the E. M. F. is sufficient to cause the current to leap, or when there is a striking distance which is easily perceptible, the case may properly be called "high potential." It implies the existence of thousands of volts potential difference. The strain on the dielectric or insulating material is such that a high insulation resistance is demanded to prevent large leakage. The current passes at a "high tension," or is a "high tension" current. The time at the author's disposal will not permit more than a brief reference to different combinations of apparatus in which high potentials may be effectively employed.

Let it be desired to transmit several thousand horse power from a water-power to a distance of, say, twenty miles or more, and deliver it at one point as power. What plant should we use? Direct current, or alternating current? Owing to the difficulty of constructing commutators which are suitable for such high potentials as five thousand volts, especially where the current is large, it is evident that neither dynamos nor motors can be used in which the full potential is either generated or used. This assumes the use of a direct or continuous current as the means of transmission. In such case, either the voltage must be kept down to, say, 1,500 to 2,000 volts, or the dynamos and motors must be run in series sets.

It is questionable whether commutators can be commercially successful on which the pressure exceeds 1,500 to 2,000 volts, with large currents flowing. They are very difficult to construct and to maintain. Besides, they require to have so many segments between the brushes that the armature winding and connecting is made more delicate and liable to injury. The cost of construction becomes excessive. When the voltage does not exceed 1,000 volts these difficulties do not present themselves. Hence to use continuous currents in the case assumed and to take advantage of a high line-potential to secure immunity from line losses and allow a moderate outlay in copper to suffice for the transmission, it will be necessary to connect several dynamos in series in the generating station and several motors in series at the receiving station. These machines may be belted to a common shaft. With this arrangement it would be possible, by mounting the machines on insulating bases, to work with such high potentials as 20,000 volts by having 20 machines of 1,000 volts each connected in series at each end of the line. This with each machine of 500,000 watts output, would transfer energy at the rate of 16,000 h. p.

The machines, both generators and motors, could be series wound and be practically self-regulating as to speed under varying loads, providing all the machines are mechanically driven together as one or deliver power together. The construction presents no great difficulties, and the efficiency under all loads, except quite light loads, could be made high. But the condition of combined driving, and delivery of power, destroys much of the attractiveness of such a system. Considerable portions of the plant could not be thrown off without destroying the conditions. There is no method of transformation for direct currents which would not involve the commutator difficulty. It is evident that we must look to alternating currents as a means of transmission at high potentials.

For large transmissions it is evident that the system adopted should permit the construction of dynamos of as large capacity as 1,000 h. p., so as not to multiply machines to too great an extent. It is also requisite that the construction be such that parts are readily accessible and easy to repair in case of accident.

In the employment of alternating currents we have the choice of various ways of working. It is probably not easily practicable to construct alternating dynamos or motors to make use of currents at over 3,000 or 4,000 volts without transformation. It would appear, then, that if the distance is great enough to compel the use of currents at higher pressures than three or four thousand volts, transformation will become necessary; in which case the voltage of the generating dynamos and of the receiving machines can be as low as desired.

But the interposition of a set of transformers for raising the potential at the generator end and another set for lowering it at the receiving end, is an added expense for plant which must be balanced against saving of cost of construction of the machines and line. The percentage of loss involved in the use of transformers, due to losses incurred in the transformation, is not necessarily so great as to be serious. It can probably be brought down to about 5 to 6 per cent. under full load for the double transformation.

In the transmission of power by such a method the losses, then, are those of the line, the double transformation and the dynamos and motors. The total loss need not exceed 25 per cent. under full load condition.

If the transmission is for lighting, and the transformation down at the receiving end is made to give the voltage required for the lamps, the motor losses would be supplanted by losses on the local mains, or local distribution. If motors be run from such lines the losses are of course increased by the drop in reaching them, depending on their distance from the transformers which feed current to them. It will sometimes be found practically impossible to transform down directly to lamp potential from the high potential of transmission. This is the case when it is not permissible to carry the high potential lines to transformers placed here and there in a city. In such cases an intermediate transformation may be resorted to, but it, of course, involves more cost of plant and another three per cent. loss or thereabouts. Dear fuel and very abundant water-power may sometimes warrant such procedures. In all such cases of cumulative drop, difficulties arise from the fall of potential under load, and adjusting devices at the transformers or on the lines may require to be employed.

Fortunately variations in the voltage may, with alternating currents, be effected by the use of variable reactive coils instead of resistances, and regulation may be obtained with fair economy. As regards the single-phase alternating currents, involving the use of but two lines, which is the system commonly used, nothing more is required for such work as lighting, and it is to be hoped that self-starting effective motors may be forthcoming for use on such systems. Progress has certainly been made towards securing such motors and a year or two hence we may find many in active service on existing lines.

For power transmission a reversed alternating dynamo, if of a good type, is also a good motor when brought to synchronism, and it has the advantage of maintaining a speed as regular and constant as the speed of the generators at the other end of the line, but it has also the serious disadvantage of requiring to be brought up to full speed before it will work at all. It is essentially non-starting. Too much complication is introduced into the plant by the introduction of elaborate devices for starting. It has been proposed to start such motors by connection with a small, not necessarily very efficient motor of the self-starting variety, of which there are several quite suitable for the purpose, working by alternating currents of single phase. Where the power is to be delivered *en masse* at a receiving station it is possible that such methods of working may become important. Alternating dynamos are now constructed which, when even of moderate capacity, have a commercial efficiency of considerably over 90 per cent. and therefore approach, if not equal, the best types of continuous current apparatus. These machines reversed and used as motors may be expected to have an efficiency equal to their rendering as dynamos and are easily made self-exciting.

Great interest has recently been excited from the use of the three-phase alternating current, or rotary current, in the Lauffen-Frankfort transmission. This experiment, covering a distance of over a hundred miles, was successful so far as the technical matters involved were concerned. It was not intended as an exemplification of a commercial transmission. It served its purpose in proving the possibility of working with alternating current of very high potentials, and also showed in a striking manner certain features of the multiphase system.

Let us assume that we have a station in which the dynamos are excited by a continuous current, and that the armatures are provided with a three-branched conductor similar to a Thomson-Houston arc machine, but with three collector rings instead of the three commutator segments, three separate brushes bearing on the rings. Or, if the field of the dynamo revolves, the connections are made directly to the stationary armature coils. The three wires may, in other cases, be connected to points in a continuous or Pacinotti winding, such that they are virtually taken at 120 degrees apart in a bipolar machine, 60 degrees in a four-pole, etc. In such cases we will have three lines leading from the generators, in which lines alternating currents may flow with the waves displaced relatively 120 degrees, or in which, when any one current wave is at its maximum, the two others are nearly at their mean value, one rising and the other falling. This has been called a "rotary current" abroad, but it is no more rotary than any current is. In fact, it is no more rotary, as a current, than is steam which is fed by three steam pipes to three cylinders of an engine, in which the cranks are set 120 degrees apart around the shaft. It is true that such currents are capable of producing a rotary magnetic field, just as is a two-phase system, but a rotary field is also produced by the rotation of a set of brushes around a commutator attached to an armature of the ordinary continuous current type, such a current being passed in by the brushes.

By the use of transformers, the three-phase alternating currents can be transformed up or down as with a single-phase current. Specially constructed transformers permit a combination of the magnetic circuits of such transformers in a manner to form, as it were, a triplicate transformer, having certain advantages which will not here be dealt with. It is evident, however, that the advantages of high-potential transmission may be obtained in this system by transformation, while low or moderate potentials may exist at the dynamos and motors.

In the reconversion of energy of three-phase currents back into power we have the choice of two types of motor: 1st, the reversed three-phase generator which synchronizes in speed perfectly with the generator; 2d, the three-phase non-synchronous motor which changes in speed or requires regulaton for differences of load.

The former requires its field magnets to be excited with continuous currents, and will not necessarily start itself. It will, however, start along with the generator while the latter is starting, if the fields of both be excited strongly and no great load be on the motor machine. The machine is simply a three-phase dynamo reversed, current being delivered to the three connections of the three-branched armature conductor, and the field excited continuously as in the dynamo.

The non-synchronous type of motor becomes, by proper proportioning, practically capable of maintaining a speed which does not vary over a few per cent. from light to full load; it requires no exciting current and starts under load. In construction it is simply a structure in which the rotating field, set up by three currents of a three-branched or suitably arranged conductor in a laminated iron mass called the field, drags around a movable armature carrying a system of closed conductors in which strong currents are set up by the moving lines from the field, which acts to close its magnetic circuit through the armature iron. Thus the rotating bundles of magnetic lines in cutting the armature conductor push such conductor along by virtue of the reaction of the opposing currents set up in the armature conductors or closed circuit. Such motors, not being reversed dynamos, cannot act to generate current if revolved by power. Their great advantage is that they may be placed anywhere where convenient to receive current from the mains direct or from transformers, they may be started or stopped at will and have no commutators. That they may be made quite efficient is evident; that is only a question of proper designing. Both forms of motors mentioned for three-phase currents will doubtless have their uses. While lights may be run from three-phase current systems by transformers, or directly from the mains if the potential be proper, such systems possess no peculiar advantages over the single phase systems except that in the generation of three-phase currents a smoother action of the dynamo is obtained and probably therefore a slightly increased economy, or perhaps a little greater output.

There is another important way in which the three-phase currents may be utilized at the receiving end. They may readily be transformed into continuous currents of low potential or of any potential practicable for commutation. The means for transformation in this case is a motor generator of special construction. It posseses an armature winding and connections suitable for three-phase currents, a field magnet system excited by continuous currents from any suitable source and acting on the armature, a secondary winding on the armature, or the same winding as that connected to the three-phase mains, with the usual numerous connections to the segments of a continuous current commutator, upon which brushes suitably adjusted take off continuous currents. These may be used for lighting, for running continuous current motors, etc. Motor-generators giving 500 volts continuous current, 220 volts and 110 volts, are easily worked from the same system of three-phase mains. The excitation of these machines may be obtained from their own commuted currents, they are self-propelling after having been started along with the generating plant, or may easily be brought to speed before connecting with the three-phase supply by continuous current from another machine in work. They can be compounded for drop of potential in themselves and the lines leading to and from them.

The future supply of electricity in a large city, for all purposes, at any desired voltage of continuous or alternating current, would seem to involve a system about as follows:

A generating station conveniently located for obtaining water for condensing, cheap fuel delivery, and ready disposal of ashes, containing huge triple compound condensing engines driving large dynamos, delivering either directly or through transformation upward high potential three-phase currents a system of high potential mains for three-phase currents, probably consisting of sets of three conductors with a heavy open braid or network covering, tightly woven on, and drawn into an iron pipe filled with insulating oil placed underground to avoid atmospheric disturbances; sub-stations containing compounded three-phase motor-generators feeding into the street mains at the desired potential for lights and continuous current motors; motor-generators feeding currents of suitable potential for street car propulsion; alternating current transformers delivering currents of alternating character at desired voltage for lighting, and for driving commutatorless three-phase motors. There is no electrical service which could not receive its supply from such a system. The time is perhaps not quite ripe for such a comprehensive scheme, but its advantages are obvious to those familiar with the present conditions of supply in large cities.

Time has not permitted the extension of this paper to cover matters of detail, however interesting, and an attempt has simply been made to review in a brief manner the salient points of several systems involving high potential transmission. The purpose of the paper has not been to present any of the history of the growth or development of these various systems touched upon, nor to enter into any of the refinements of theory or practice with such systems, a proper consideration of which question would be very lengthy and consume more space than is at our disposal.

The question may be asked, What are the highest potentials which can ever be made available in electric transmission? Any answer given will necessarily imply foretelling the future practice, a very hazardous thing to attempt. Such answer, may, however, be taken to relate to either a single-phase alternating system or a multiphase, the only difference being in the number of conductors employed. In fact, it is conceivable that the number of conductors in a single-phase system be reduced to one central conductor surrounded by a tube or by several conductors, all enclosed and insulated from a surrounding pipe. Let the pipe be filled with oil and the conductors be separated by being wound with an absorbent net of dry cotton, and let the covering of oil extend over the conductors and be unbroken, practically, over the whole of the high potential conductor, including the fine coils of the transformers at each end of the line, and we have a system in which the employment of very high potentials may become quite feasible. If we provide in the thickness of our oil insulation a sufficient margin of safety from puncture, and so calculate our line that its self-induction and capacity compensate for each other's effects, it would seem that there would be no difficulty from leakage, or from Ferranti effects, as they are called. The condenser effect of the Ferranti cables is large while the self-inductive effects are small. Condenser action tends to accelerate the phase at the dynamo and self-induction retards or lags the phase of the currents and it would seem that by distributing the capacities and self-inductions properly the normal phase without either acceleration or lag could be maintained.

A layer of good insulating oil one inch thick between rounded smooth metal surfaces will equal in resistance to puncturing a potential which will cause a spark in air over 30 inches long. At least the author's tests on this subject point to an approximate relation of 1 to 35 or 40 in dielectric strength between air and good heavy paraffine oil. As nearly as can be estimated, a spark between rounded surfaces at 30 inches in air, represents not less than 500,000 volts and the author's experiments go to show that such potentials can be "kept down," so to speak, in a bath of oil. Whether the condenser effects of a long line would introduce serious difficulties it is impossible to say, but provided that the rate of alternation or periodicity be kept low and the insulation maintained by covering every inch of the high pressure conductors in, say, two inches thick of oil, it might even be possible to work with 500,000 volts. Allowing a loss of only 10 per cent. or 50,000 volts with a double conductor conveying 200 amperes, each conductor having about $\frac{1}{12}$ of a square inch section, a distance of about 240 miles would be covered and the energy carried would be 100,000,000 watts or over 130,000 h. p.

These are striking figures and are only given by way of illustration. They may never be needed to be used in practice, yet the difficulties of realization are less than at first appears; the condenser action of the line being the most serious matter to be dealt with. Such a line is even safer so far as life risks are concerned than an overhead line of much less pressure. In fact it may be said to be practically safe. Any interference with the line is difficult on account of the pipe enclosing it, and on the first weakening of the insulation or before a break in the pipe became complete, a short-circuit of a moderate current would take place and the fuses be blown at the ends of the line. Pipe lines are laid for the conveyance of oil—why should they not be laid for the conveyance of electric energy where it can be done economically? Looked at from the standpoint of very high potentials, Niagara may be said to be gradually approaching the surrounding cities.

"A DAY WITH EDISON AT SCHENECTADY."

A VERY handsome volume of photographic views of the great Edison shops at Schenectady has been prepared by Messrs. W. H. Butler and E. Jones, who are in the service of the Edison General Electric Co. at Schenectady, N. Y. The album is 9 by 11 inches, bound in heavy boards, and contains about 150 photographs, several being artistically grouped on a page. There are a great many portraits, including a group of all the foremen, and individual ones of Messrs. Edison, Insull, Kruesi, Turner, Weber, Parshall and others. Besides these, there are pictures of some 40 or 50 different departments, showing in a very clear and interesting manner just how the work is done. The photographs are all beautifully taken and exceedingly well mounted. The album is one well worth having, and we entertain no doubt that it will be largely in demand. It is to be sold by subscription at $6 each, and all inquiries may be sent to the gentlemen above named. Mr. Butler, who has charge of the work, is a Yale man and one of the students at the works. He has been quick to see the most interesting points and, with the help of Mr. Jones, has turned out a book of unusual interest and value.

LIGHTNING ARRESTERS, AND THE DISCOVERY OF NON-ARCING METALS.[1]

BY ALEXANDER J. WURTS.

DURING thunder storms electric wires become charged from the atmosphere with an electric potential, different from that of the earth; there is then a tendency to establish an equilibrium, that is, for a discharge to or from the earth as the case may be. If this discharge be left to choose its own path, it will select one or many of the weaker points, usually the most vital part of the system, and there rupture the insulation. It therefore becomes necessary to rid the line of this charge in some suitable manner, and without allowing it to damage any portion of the system. This is usually accomplished by the well-known air-gap lightning arrester. Benjamin Franklin, nearly one hundred and fifty years ago, drew sparks across an air gap from a charged conductor very much as we do it to-day. He, however, did this to demonstrate the presence of the charge, while we do it for good riddance.

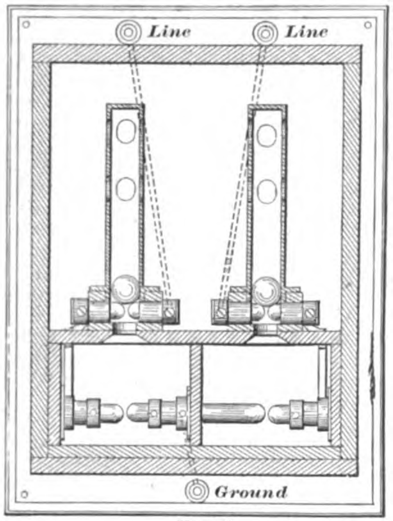


Fig. 1.

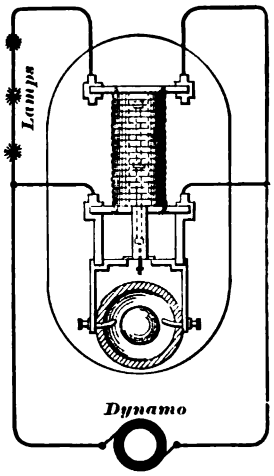


Fig. 2.

Shortly after the erection of the first telegraph line by Morse in 1844, it was found necessary to provide means for discharging the line during thunder storms, and numerous devices were brought out and patented for this purpose. The main features of lightning arresters from that time till recently have been the "spark gap" and the "kicking coil," the latter being interposed between the discharge circuit and the apparatus to be protected. The spark gap arrester on telegraph lines answers the purpose admirably. When, however, electric lighting was introduced, the lightning arrester problem became more difficult in consequence of the dynamo short-circuit that invariably follows the discharge. It then became necessary to provide means for promptly interrupting this short-circuit, and so the fuse was added, and then there followed all kinds of automatic devices for interrupting the short-circuit and restoring the arrester to its normal condition. But most of these devices have been more or less defective and unsatisfactory; and now that high potentials are used, the proper interruption of the short-circuit becomes more difficult than ever. The ideal lightning arrester would be a simple discharge gap of such a character as not to permit a short-circuit of the dynamo, or better yet, metallic connections to the ground without dynamo leakage.

When I first became interested in this subject, I was naturally guided somewhat by previous practice, which had been to provide with each arrester and discharge circuit an automatic circuit interrupter. Fig. 1 illustrates my first practical step in this direction, and represents the Winsor-Wurts lightning arrester, the fundamental idea of which emanated from Mr. Paul Winsor, who proposed that a discharge gap be placed in the neck of a bottle, the idea being that the heat of the arc formed by the short-circuit would sufficiently expand the air in the body of the bottle to blow out the arc. With this idea as a nucleus, the arrester depicted in Fig. 1 was evolved. Referring to the figure, it will be noticed, without going into detail, that the arrester is double-pole and that each discharge gap is placed in the centre of an air chamber. In the upper part of each of these there is a slotted passage, which might correspond to the neck of a bottle, and in which there is placed a second air-gap in series with each of the others. The second air-gap is bridged with a carbon ball, the latter being held in place by tubes having vent holes in the sides and rubber bumpers at the top. The action which takes place when a discharge to ground is made with a resulting short-circuit is as follows: The arc at either or both of the jumping spaces instantly heats and expands the air in the respective air chamber, which, rushing up through the slotted passages, blows either or both carbon balls to the top of the tubes. The arc formed where the circuit has been broken by the projected carbon ball is, at the same time, instantly blown out, thus completely rupturing the circuit. The only demonstration is a quick puff as the air rushes out of the holes near the upper ends of the tubes. The object of the holes is obvious. As the balls are confined in the tubes they at once drop back to their former positions, and thus automatically place the apparatus in a condition ready for another discharge and short-circuit. In testing this arrester the terminals are connected to the circuit of a thousand-volt generator. The air spaces are bridged over with a fine wire to take the place of an actual discharge. Then, by the throw of a switch, the full pressure of the machine is placed on the arrester. There is an enormous rush of current, the temporary wire bridges fuse, arcs are formed, the air expands with an explosion, the balls fly up, more arcs are formed, tongues of fire shoot out of the holes in the tubes, the upper arcs are blown out, the balls drop back to their normal positions, and all this happens like a pistol shot, without causing more than an insignificant flicker in the lamps. It is very curious to notice that if this short-circuit is made on the crest of a wave of an alternating current, the report of the explosion is much sharper and louder than when the circuit is closed at the instant the wave is at or near the neutral point. I might add here that, after short-circuiting a thousand-volt 3,000-light machine through such an arrester about 400 times, there was not the slightest deterioration to be noticed anywhere. Those who are not familiar with this kind of work will hardly appreciate this last fact, or realize what is accomplished each time the arrester "goes off."

Soon after this arrester was completed, steps were taken to adapt the same principle to an arc circuit lightning arrester, which resulted in the one illustrated in Fig. 2. By referring to the figure, you will notice that a vertical solenoid provided with an iron core is connected in the main circuit beyond the point of contact with the discharge circuit. The discharge electrodes are curved arms which swing freely through the sides of a cylindrical air chamber, and the construction is such that when the core falls, the discharge electrodes will be forced out. The action is then as follows: Under normal running conditions the core is held up in the solenoid, but if a discharge occurs from both sides at once, short-circuiting the machine through the discharge points, the solenoid will at once lose its power, the core will fall and force the discharge arms out through the holes in the walls of the chamber. This action would draw out arcs three inches long, and the heat thus generated is sufficient to cause a sudden expansion of air in the air chamber and thus blow out the arcs even though the current be but ten amperes and the pressure 3,000 volts. Without the device just described for lengthening the arc, the heat developed would have been insufficient. In short-circuiting a 50-light machine through this arrester, there is a scarcely perceptible flicker in the lamps, the core drops, the short-circuit is opened and the core drawn back into its normal position ready for further action, all in an instant of time. Although I have used an electromagnetic device in the construction of this type of arrester, it will be noticed that the placing of a coil in the lightning arrester circuit has been avoided, so that even though every discharge has to pass through this coil to reach the discharge points, yet from this point on, the discharge has a non-

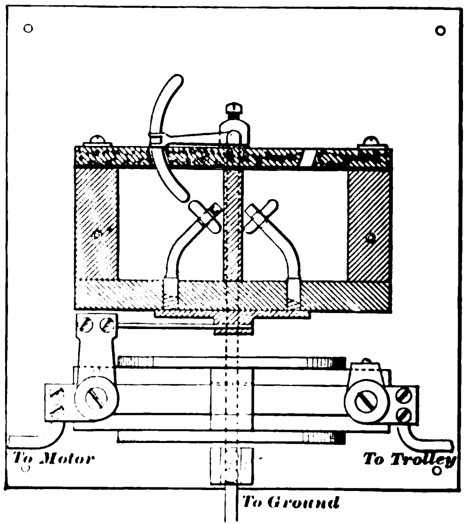


Fig. 3.

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[1] A paper read before the American Institute of Electrical Engineers, New York, March 15th, 1892.

inductive path to earth through the arrester in preference to the dynamo.

Neither of these arresters would interrupt a short-circuit on a 500-volt direct current generator, so after some futher experimenting the arrester shown in Fig. 3 was evolved. Referring to Fig. 3, it will be noticed that there are two air chambers, in each of which is a fixed carbon discharge point. Above these chambers is a curved carbon swinging freely from one chamber to the other through suitable openings, so that either end of the curved carbon, as the case may be, shall come into close proximity to either of the fixed discharge points. The action is as follows: When a discharge takes place, it passes to one of the fixed discharge points, depending upon the position of the curved carbon, then across the air space to the curved carbon, and from there to the ground, as shown in the figure. The dynamo current then following, causes an arc to be established between the curved carbon and one of the fixed points, and the heat generated by this arc expands the air in its respective chamber, increasing the pressure therein, and causing the curved carbon to be instantly blown from one chamber to the other. This ruptures the arc and adjusts the arrester for the next discharge. In testing this arrester, 500-volt and 1,000-volt generators have been repeatedly short-circuited through it, and in every case the circuit has been instantly broken without injury to the dynamo, and the arrester has as quickly reset itself in readiness for future use. In one of the tests made to demonstrate its promptness and reliability, the fixed points were so adjusted as to touch the curved carbon in either of its two normal positions. A 1,000-volt generator was then short-circuited through the arrester, which resulted in the circuit being repeatedly opened and closed without injury to either dynamo or arrester. This power circuit arrester was afterwards much improved, and finally took the form shown in Fig. 4, and the arrester shown in Fig. 1 was also finally changed to this form. This arrester is made of iron and marble, and its advantages over the others are its non-combustibility and the double break in connection with the air blast. Fig. 5 illustrates the same arrester, fitted into an iron box lined with asbestos, and in this shape is adapted to either car or pole use.

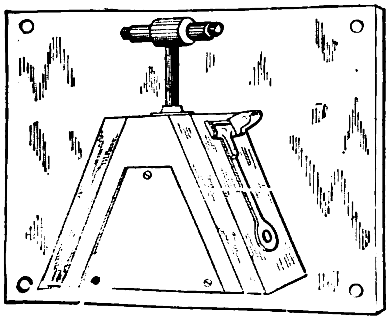


Fig. 4.

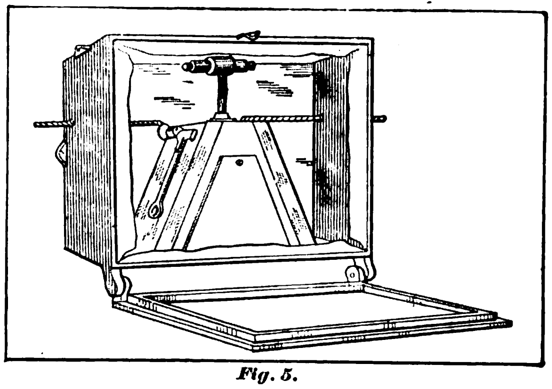


Fig. 5.

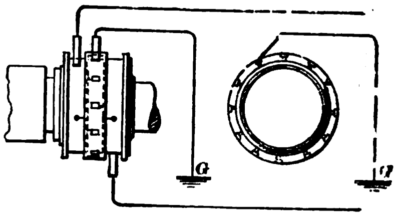


Fig. 6.

So far you will observe that my one object had been to provide a simple, reliable and non-inductive circuit interrupter. In this I had succeeded as far as immediate wants were concerned, but with the prospects of higher voltages in the near future the problem seemed but imperfectly solved. The experiments of Lodge, Hughes and others were carefully studied, and I finally decided that it might be well to repeat some of them. So, one day, while casting about for some suitable means of experimenting, I happened to be passing under a driving belt; my hair stood on end, and my body became charged. Of course somebody had to touch my ear (that seems to be the proper thing to do under the circumstances), and my body became discharged. That evening, while thinking over the events of the day, my thoughts rested on this belt, the electrified atmosphere around it, and the charging and discharging of my body, and I wondered whether the phenomena observed were not very similar to those experienced during thunder storms. On the following day I stretched about four feet of No. 14 insulated wire under a belt, parallel to it, and about two inches below it. I then brought the ends to a convenient place where I could ground the wire, or not, as I chose. The room was then darkened, the belt set in motion, and a most beautiful sight presented itself. Between the belt and the wire were seen soft purple streamers, giving the appearance of a film connecting the belt and wire. In some places these streamers were more dense than others, and in this were suggestive of the Northern Lights. There was no disruptive discharge at all between the belt and wire. On bringing the bare end of the wire within one-quarter of an inch of a ground a continuous discharge took place. When one end was well grounded no spark could be drawn from the other end. When one end was grounded through a choke coil consisting of about 40 turns of No. 14 wire, small sparks could be drawn from the other end, showing the impedance offered by the coils to the discharge. When neither end was grounded, both ends showed "side flash" every two or three seconds. So far, these results seemed to correspond with the experience met with in electric systems when exposed to the influence of thunder storms. The conditions also seemed to be very similar. Here was a wire stretched through an electrically disturbed atmosphere; the wire became charged, and the charge passed readily to ground through a metallic discharge circuit containing an air gap. An induction coil impeded the discharge, and when there was no ground connection there was side flash. All these results seemed to correspond with practice.

The thought then occurred to me, "What would happen if I were to string a second wire near and a parallel to the first, and ground it, leaving the first wire insulated?" A second wire was quickly strung, but before making the ground connection the following observations were made. The purple streamers seemed equally divided between the first and second wires, and either would give about equal sparks. On grounding the second wire no indication of a charge on the other could be obtained. The streamers were now all directed to the second wire, and the first was as inert as a block of stone would have been. If, now, in these laboratory experiments, there were reproduced the conditions existing between electric wires and the atmosphere during thunder storms, then, to prevent wires from becoming charged, all that would be necessary would be to stretch a grounded wire near and parallel with the wire to be protected, and, in fact, it would seem as though one such grounded wire would protect all the wires that could be strung on any one line of poles. An explanation of these phenomena is not far to seek. An insulated wire lying on the surface of the earth cannot become charged from the atmosphere, because the latter is at the same potential as the earth; but an insulated pole line can be, and is charged when exposed to the influence of thunder storms, because the atmosphere surrounding the wire is at a different potential from the earth; therefore with an insulated pole line, and an adjacent grounded parallel wire, the grounded wire in effect transfers the earth to the level of such wires, but if a grounded wire near and parallel to an insulated wire in effect causes the earth to be transferred to the level of the insulated wire, then the insulated wire cannot become charged. The grounded wire running over the poles will relieve the atmosphere in its neighborhood of any difference of electric potential that would otherwise exist between that neighboring atmosphere and the earth, and the insulated line would then fail to become charged. Soon after performing this experiment, I learned that such an overhead grounded wire had been used to great advantage, and that being the case was greatly surprised that it was not in more general use.

I next replaced the wire I was using, which was much battered and bruised, with a new wire, and found the charge much diminished by the superior insulation. The latter was then replaced by bare wire insulated with a glass tube. The spark now was scarcely perceptible, being about the size of the spark obtained from a Leclanché cell, and even this could be obtained only after several minutes of charging. These results seemed to indicate a gradual charging of the wire by more or less perfect contact with an atmosphere having a different potential from that of the earth. With the idea of gradual charging in mind, the following plan was hit upon for a lightning arrester. The first conception was to alternately ground both poles of a generator over a very small air-gap, and at rapidly recurring intervals. The improved plan, however, was to alternately dead ground the poles of an alternator at every neutral point in the electromotive force wave, the idea being to so constantly discharge the line in this manner, as to effectually prevent a charge from attaining any considerable intensity, and at the same time avoid the short-circuit which now invariably follows the discharge over the air gap of our present arresters. The method of carrying out this plan will be understood by a glance at Fig. 6. Upon experimenting, I found that an alternator could be short-circuited at the neutral point without a spark. If the short-circuit occurred a little before the neutral point, that is, on a decreasing electromotive force, there was slight sparking, but no tendency to hold on. If the short-circuit occurred at all after the neutral point, a furious arc was established which would hold on indefinitely.

This form of arrester has not yet been tested in actual practice, but it will be during the coming season, and I have great hopes that it will not only successfully discharge the line, but effectually prevent any considerable accumulation of the charge. Of course this form of arrester is only adapted to alternators.

For direct current use I have devised something quite similar, the principle of which will be understood by reference to Fig. 7.

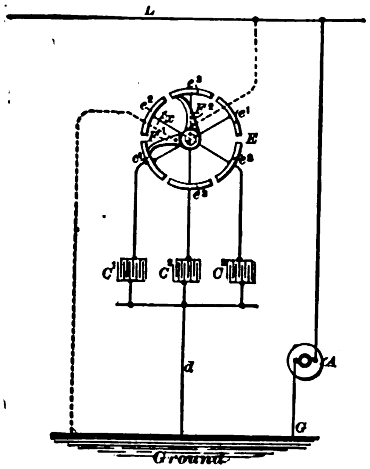


Fig. 7.

Referring to the figure, A is a generator, one pole of which is grounded at G, the other being connected to the trolley line L; E is a circuit controlling device consisting of fixed commutator-like metal pieces e^1, e^2, e^3, opposite pieces being electrically connected; F^1, F^2, are brushes insulated from each other and revolving at a high speed in a direction indicated by the arrow; F^1, is connected to earth, and F^2, to the line; e^1, e^2, e^3, are connected respectively to three condensers, C^1, C^2, C^3, the latter being grounded as indicated at *d*. The action is as follows: With the brushes in their present positions, the line is connected through F^2 and e^2 to condenser C^2. This condenser is therefore being charged while condenser C^1 is being discharged to earth through e^1 F^1. When F^2 passes to e^1, condenser C^1 will be connected to the line, and become charged while condenser C^2 will be discharging through e^2 and F^1. Thus by the continued rotation of these two brushes, it will be seen that the trolley line is being constantly discharged into a fresh condenser.

This arrester has also not been tested in actual practice, but if my hopes are fulfilled it will accomplish for direct current circuits what the neutral point arrester is intended to accomplish for alternating circuits, the idea being in either case to take off the charge bit by bit, but at such rapidly recurring intervals that the line will be kept practically free from charge, or, at least prevent the charge from obtaining sufficient intensity to damage any portion of the system. Personally I am much interested in these two arresters, which practically afford direct connection to earth without dynamo leakage, and would like to dwell on them more in detail, but time will not permit.

Referring once more to my experiments with charged wires, I would say that they were nearly all repetitions of experiments quite familiar to all of you. Let me, however, call your attention to one of them which I am confident is not old in detail. Referring to Fig. 8, L is a Leyden jar, *l* is a bare line wire, a portion of which is coiled and immersed in a tank K of water. This tank is well grounded. Line *l* is continued through induction coil C and then grounded as shown; *b* is a gap discharge circuit. Now with a spark at A there was a small spark at *b*; with a gap at *d* there was sparking at *d* and *b*, spark *d* being larger than *b*. With a gap at *e* sparks were obtained simultaneously at *d*, *b*, and *e*. Induction coil C was either a primary or a secondary of a 40-light converter. When C was primary, spark *e* was very small. When C was secondary, *e* was larger, but still small when compared with *d* and *b*. From these experiments I learned two lessons, both of them old, but in books they did not impress me as they did in practice. The first lesson was, that I must not expect one or two discharge circuits to discharge the many miles of wire that we have in our lighting and power circuits. The second was that a "kicking coil," no matter how great its impedance, would still take a portion of the discharge. My final conclusions then were. That in order to afford the best possible protection for electric plants, the wires must fairly bristle with discharge points properly located in discharge circuits. With this idea in mind a cheap and effective pole arrester seemed to be the proper thing to look for. My experiments from this time on led me to a discovery so remarkable, and so contrary to all previous ideas, that I am going to read you a description of them.

In designing the arresters already described, I had followed closely the rut of previous practice, which had always been to provide with each discharge circuit, a circuit-interrupting device. Upon reflection, however, it was evident that one circuit interrupter placed in the main circuit would interrupt the arc on any discharge circuit. For a moment the problem of a simple pole arrester seemed solved, but on second thought the difficulties and inconveniences inseparable from any automatic main circuit interrupter appeared to be insurmountable, and the idea was no sooner conceived than it was abandoned. And yet, poor as it was for practical purposes, it proved a good stepping stone, and led to the following plan, viz.: To provide the line with ordinary discharge circuits, that is, with the well-known saw-tooth protectors, made of carbon so that they would not easily burn away; and then in the station, between the generator and the first discharge circuit, provide an automatic device which, upon the passage of an abnormal current from the generator, would instantly short-circuit the dynamo and as quickly open again, the intention being that should a short-circuit occur out on the line through any of the discharge circuits, a short-circuit at the dynamo would so reduce the pressure on the line as to render it impossible for an arc to maintain itself. Then, any such arc having been extinguished, the short-circuit at the generator could be interrupted, and the service would continue as before. This idea meeting with general approval, steps were at once taken to put it to a test in the following manner: To a 1,000-volt alternator there was connected a circuit consisting of about 100 yards of line wire, and in this circuit there was placed a pair of carbon dischargers having saw-tooth edges, and a $\frac{1}{16}$ in. air-gap, also a switch. In shunt with this circuit, that is, directly across the terminals of the generator, there was connected a simple device (it will not be necessary to explain its construction) which, upon the passage of an abnormal current in the circuit containing the discharges, would instantly short-circuit the generator and as quickly open again. All the connections being made, the air-gap was bridged with a bit of tinfoil to start the arc, and the switch thrown. The actions that followed in an unconceivably short space of time were these: The tinfoil burst with a snap, an arc was formed, the automatic short-circuiting device operated, the arc was extinguished and the short-circuiting device opened. So far, this was exactly what was anticipated, but no sooner had the short-circuiting device opened, and the electromotive force returned to the line and the dischargers, than the dynamo pressure forced an arc across the air-gap once more, and the whole operation was repeated. This repetition was found to be due to the fact that when the arc was first established between the carbon saw-tooth plates, the carbons were heated to a white heat which, not having time to dissipate itself before the pressure returned, the dynamo current found a sufficiently easy path over the heated air-gap to re-establish an arc. However, the test being otherwise satisfactory, success seemed assured, for all that was necessary now was to use solid metal discharges that would readily conduct the heat away, and the trouble above cited would no doubt be avoided. So the test was repeated, using the same apparatus as before, except the dischargers, which now consisted of three solid, round, brass rods, 1 in. in diameter and $1\frac{1}{4}$ in. long, placed side by side with their axes parallel to each other, and having air-gaps of $\frac{1}{16}$ in. That is, the line was connected to the two outside bars, leaving the middle one idle to be connected to ground, as would be the case in a double-pole lightning arrester. The air-gaps were bridged as before with tinfoil to start the arc, and the switch thrown. The test was successful in the highest degree—too successful, in fact, not to arouse suspicion. So I thought I would repeat the experiment, and see how the dischargers would behave without the short circuiting device. The result was an overwhelming surprise, for at the dischargers there was merely an insignificant spark scarcely larger than a pea. The experiment was tried again and again, with the same result. Any electrician would have predicted a brilliant display of fireworks. The most plausible theory advanced to explain this action was that the electric motor driving the dynamo being small, its speed was

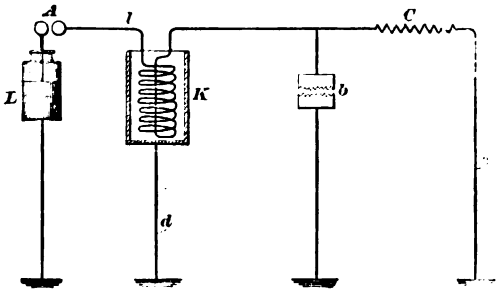


Fig. 8.

probably reduced to such an extent by the overload suddenly thrown upon it, that the electric pressure was at once reduced below that which would be necessary to maintain an arc across the air-gaps. On second thought, this theory would have seemed improbable, but at the time it was accepted without a question. In a few days a test was again made, this time a small engine being used for motive power, and the same results were obtained as before. The afternoon of the same day both engine and generator were changed, with like results. In the meantime a little reflection seemed to indicate that perhaps this strange action was not, after all, due to the slowing down of the motor, but to the possible cooling effect of the metal dischargers on the arc. With this idea in mind, I had constructed, a set of three dischargers similar to the first, but much larger, 2½ in. diameter x 3 in. long, thinking that if a little metal was good, more would be better, and that perhaps with a large generator the mass of metal would have to be greatly increased to produce the results already obtained. This large discharger was connected to a 3,000-light, 1,000-volt alternator; the air spaces were bridged as before; and the scene which followed beggars description. The large metal bars were melted like beeswax in a great ball of fire. My disappointment was keen, for I thought I was on the verge of making a discovery, and that in the previous cases the comparatively feeble engine had not been the cause of the action. Thinking, however, there could be no harm in melting up the smaller discharger, I connected it in where the larger one had been, bridged the air space, and threw in the switch. Imagine my astonishment on hearing an insignificant snap like the crack of a toy pistol, and seeing an arc as before no larger than a pea. I then pushed a nickel down into one of the air-gaps to short-circuit it, and leave only one air-gap for the arc, and tested again, with the same results. Two questions now presented themselves: viz., what were the differences between the large and small dischargers other than the size, and why did the small discharger behave in this altogether unlooked-for manner? The answer to the first question was readily found by tracing the two dischargers back to their source, and there learning that the larger one of the two was made of cast brass, containing certain proportions of tin and copper, and that the smaller one was made of hard drawn brass, containing certain proportions of zinc and copper. These facts at once established two differences between the dischargers other than mere size: one was, their physical structure, the other their composition. Which of these two differences caused the difference in their actions? A discharger composed of cast brass containing the same proportions of zinc and copper as the hard drawn brass discharger was made and tested, and found to work perfectly. It was thus determined that the physical structure of the metal had no influence in suppressing the arc. The important difference between the two dischargers then lay probably in their composition, and I was now rapidly becoming convinced that in brass, consisting of certain proportions of copper and zinc, there must exist certain properties which do not permit of an arc being maintained between two dischargers, even with the high pressures of 1,000 volts.

It also occurred to me that possibly the shape of the dischargers had something to do with the results obtained. So the next step taken was to have a number of dischargers made up in different shapes and sizes, such as spheres, ovals, solid half cylinders, tubes and cubes; all worked well with the exception of the cubes. The cubes were placed so that their faces were separated by $\frac{1}{16}$ in. Now when the tinfoil was placed over their edges, their action was favorable, but if the tinfoil were pushed down between the faces, the arc would hold on indefinitely, and yet without any demonstration whatever, thus, even when the arc did hold on, showing a very different action from the other metals. The size of the dischargers did not seem to affect the results so long as there was sufficient metal to prevent actual melting—¼ in. brass rod melted on the third trial.

It was next decided to make dischargers of other metals, and thus learn whether there were any other substances that would give these results, and if so, perhaps some light would be thrown on the real cause of the action. The metals first tested were hard steel, hard-drawn copper, phosphor-bronze, aluminum-bronze and aluminum, all of which failed utterly. The next metal tested was zinc, and with this, most successful results were obtained. Perhaps you will now think the experimenter very slow to put two and two together, but who is there who is at all familiar with the properties of zinc, that would have suggested this metal as one likely to resist an electric arc and 1,000 volts in this manner? With such results before me, I was ready to try anything. The next metals were tin and nickel. Both of these failed. Tin made the most brilliant display of all the metals. The next tried was antimony, and it worked perfectly. The theory now advanced to explain the phenomena was that with the metals that do not allow the arc to be maintained, there is formed at the instant the arc is started, an oxide of the metal which, becoming instantly volatilized in the intense heat of the arc, chokes up the air-gap with vapors of high resistance, and so presents an effective barrier to the further passage of the current. With metals that do maintain the arc, instead of the vapor of the oxide of the metal, there is formed a pure vapor of the metal itself, and this offers comparatively no resistance to the passage of the current. When tests similar to the above were made on a 500-volt direct current generator, every one of the metals failed. The arc, however, was small and quiet with the special metals, thus even with the direct current showing a very peculiar action. Another curious phenomenon connected with zinc and antimony is this: The smaller the air-gap, the less tendency there is to maintain an arc when using an alternating current at 1,000 volts pressure. In fact, when the air-gap is two inches long the arc, when once started, will be maintained, while at ½ in. or ¼ in. the arc will not give up without a struggle, and at $\frac{1}{32}$ in. there is only a small spark caused by the fusing of the tinfoil, and the circuit is instantly interrupted.

The next step taken was to try higher pressures. A short circuit on a 2,000-volt generator, through the double air-gap discharger, failed to be interrupted; four and five air spaces also failed. Six air spaces of $\frac{1}{32}$ in. each, interrupted the short circuit instantly, but six air spaces, which would make three on each side of the circuit for the lightning charge to jump through, were strongly objected to as offering too great a resistance. A test was then made to determine the pressure needed to strike an arc across three air-gaps, and was found to be 3,500 volts, measured with a Cardew on an alternating current generator. The experimenter then procured a lightning arrester well known in the market, and one which is known to take the lightning discharge successfully, and tested it for the striking electromotive force, which was found to be between 8,000 and 9,000 volts. In order, however, to avoid any prejudice that a series of air-gaps might arouse, the following plan was hit upon: Pairs of non-arcing dischargers were mounted upon thermostatic supports in such a manner that the pairs would normally rest in contact with each other, and so that any current traversing the system would be forced to pass through the thermostats and dischargers in series. The thermostats were so arranged as to cause the two dischargers in each pair to open a way from each other upon the passage of the current. If then, a single and permanent air-gap were connected in series with this system, that is, an air-gap just sufficient to prevent the normal pressure of the line from striking an arc, and if an arc were started across it, the sudden rush of current through the thermostats would instantly introduce a number of air-gaps in the circuit corresponding to the number of pairs of thermostatic dischargers, and thus automatically open the short-circuit. This device was tested and found to work admirably. Of course after the circuit has been interrupted, the thermostatic dischargers at once return to their normal positions. In fact, this action is so rapid that if a series of these dischargers be connected in a short-circuit without a permanent air-gap, the circuit will be automatically opened and closed every two or three seconds. In order to appreciate the very remarkable action of this thermostatic device it must be well borne in mind that a very small air-gap is all that is necessary for the interruption of the circuit.

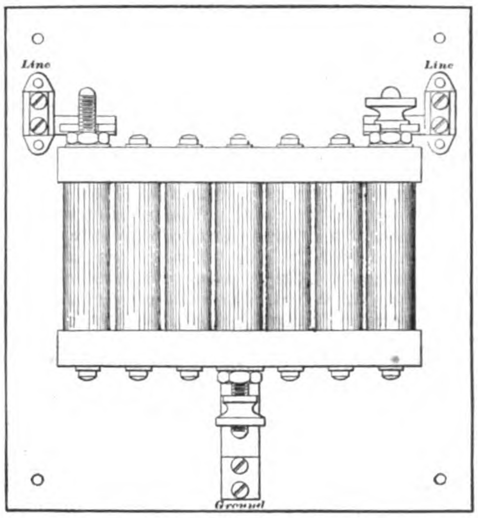


Fig. 9.

Thus far, although I had tested a number of metals, my selection had been quite at random, so that by this time I was desirous of making a more thorough and systematic investigation of this new property. The chemical properties of zinc and antimony were carefully compared without any new light. The various groups of metals were examined, and then it occurred to me that, of all the metals tested, not one of them belonged to the two groups in which zinc and antimony are found, according to Mendeljeff's grouping. The metals of the zinc group are,—zinc, cadmium, mercury and magnesium, and of the antimony group are,—antimony, bismuth, phosphorus, and arsenic. I first tested cadmium, and found it non-arcing. Then magnesium,—more, however, from a sense of duty than because I had hopes of anything but negative results. Fortunately I made this test on much lower E. M. F.'S, and found it non-arcing at 100 volts over two air-gaps of $\frac{1}{32}$ in. each. On 250 volts the magnesium caught fire, which was, of course anticipated. I then wanted to try mercury, but for the moment, not seeing how to make such a test with a liquid, I was diverted to the antimony group, and upon testing bismuth found it to be non-arcing. Phosphorus and arsenic were not tested. A final attack was now made upon the zinc group by testing mercury in the form of a copper amalgam. This test was the most successful one of all, for after a number of short-circuits on a 1,000-volt alternator, I found the surface of my dischargers had not been disturbed in the slightest degree. It will thus be seen that all available metals in these two groups are non-arcing. In searching for the non-arcing metals each test was made with two air-gaps and the E. M. F. at the time of the short-circuit was, with the exception of the test on magnesium, 1,000 volts.

Fig. 9 represents a double-pole lightning arrester made of non-arcing metal, and in connection with this paper will be readily understood without further explanation.

A TEN THOUSAND VOLT TRANSMISSION IN CALIFORNIA.

IT is reported from California that the San Antonio Light & Power Co., of Pomona, Cal., have closed a contract with the Westinghouse Electric & Mfg. Co. of Pittsburgh for a unique long-distance plant for electric light and power transmission. The power plant will be located, it is said, in the San Antonio cañon about 15 miles distant from Pomona. At this point is a fall of some 425 feet with a minimum flow of water of about 1,300 cubic feet per minute, or approximately 1,000 hydraulic horse power. This water-power will be somewhat expensive to develop as it is necessary to build a tunnel 1,300 feet long through a spur of San Antonio peak which is practically of solid rock.

From the lower end of this tunnel a steel pipe line from 2,000 to 2,500 feet in length will be constructed to convey the water down the mountain to the power house. For transforming this power into mechanical motion, Pelton wheels provided with deflecting nozzle governors will be employed. These wheels will be connected by means of an insulated coupling direct with the dynamos, no belts whatever being used in the plant. Special slow speed alternators will be installed, each machine having a capacity of 120 K. W. and driven at a speed of 660 r. p. m. Only two exciters will be utilized for the entire plant, these being driven direct by small independent Pelton wheels furnished with governors similar to those used on the large wheels driving the alternators. On account of the excessively high water pressure great precautions will be taken to provide suitable relief valves and cushions to take up the destructive water hammer effects should it ever become necessary to shut off the water. Under ordinary conditions, however, when it is desired to stop a dynamo, the nozzle will be deflected so that the stream passes clear of the wheel. The dynamos will generate their current at an electromotive force of about 1,000 volts. From the dynamos the current will be led to a switchboard of the high class marble panel type in general use by these manufacturers in their large installations.

All the switchboard instruments used throughout the entire plant, which will be completely equipped in this particular, will be marble mounted. From the switchboard the current will be conveyed to raising transformers which will increase the pressure to 10,000 volts. The lines between the power house and the towns which it is proposed to illuminate will be built of naked, hard-drawn copper wire, supported on fluid insulators. There will be two principal sub-stations, the first located in Pomona, 15 miles by the line from the generating plant, and the second in San Bernardino, 30 miles by the wire from the station. In these sub-stations the voltage will be reduced by means of transformers exactly similar to those used at the main generating power house to 1,000 and 2,000 volts; the 1,000 volt system is intended to be used to feed the lights in Pomona and San Bernardino. From the Pomona sub-station 2,000 volt lines will probably be run to Ontario, Claremont and Lordsburg. From San Bernardino a 2,000 volt line will in all likelihood be run to Colton. In the sub-station regulators will be furnished, by means of which the sub-station attendant can regulate the voltage of the distributing circuits independently of the generating plant. To effect this the Stillwell regulator, manufactured by the Westinghouse Co., will be used. All necessity for pressure wires upon the 10,000, 1,000 or 2,000 volt systems will be obviated by the use of an ingenious device known as the compensator.

The voltage used upon the incandescent lamps fed by this system will be uniformly 100 volts. Several motors will probably be employed and they will be of the Westinghouse synchronous type.

The insulators will probably be of the same pattern as those used upon the Frankfort-Lauffen installation with either double or triple oil receptacles.

The San Antonio Co. have tributary to their plant some twenty five or thirty thousand people located in a half dozen prosperous towns, and as gas and oil are exceedingly high, there is little doubt but that a large volume of business will be found. Coal is also very expensive in Southern California so that a considerable power business can be reasonably expected. This company has also several other good water-powers located upon the stream which they will develop as the demand requires.

Taken all in all, this plant is by far the highest tension and longest distributing system ever attempted in this country and perhaps it might be said ever attempted commercially in the electrical business.

The longest transmission plant for incandescent lighting previous to this in America is the one at Portland, Oregon. The power there is located on the Willamette Falls, about 15 miles from the city. The machinery is of the same manufacture as that which will be used at Pomona. Current for several thousand incandescent lamps is generated at a pressure of 5,000 volts, and transmitted at that tension to the sub-station in Portland where the voltage is reduced to 1,000 for distribution. The switchboard and regulators used at Portland are identical with those that will be installed in the sub-stations at Pomona and San Bernardino.

The dynamos in Portland are of the peculiar toothed armature form made by the Westinghouse Co. and similar ones will be employed at Pomona. Although the tension generated by the dynamos at Portland is exceedingly high, it is reported that only one armature coil has ever given out there in something like two years' operation, and as a coil can be replaced in a few minutes, this is certainly not serious.

All the machinery and devices used upon the San Antonio Co.'s plant will be furnished by the Westinghouse Co. which is a guarantee for the successful operation of the system. The plant will be installed by the local company under the direct supervision of the manufacturers, and none but the very best material will be used in the work. This plant will form one of the most important achievements in electrical transmission and is destined to be followed by numerous similar distribution systems.

College Notes.

COLUMBIA COLLEGE.

BY the action of the faculty and trustees of Columbia College, Mr. F. B. Crocker, who has had charge of the instruction in electrical work since the special electrical course was established, has now been appointed Adjunct Professor of Electrical Engineering. The actual position remains the same, and the course is continued in the Engineering Department, with Prof. Trowbridge as its head.

Personal.

MR. R. MCCARTHY, for many years at the head of the bookkeeping department of *The Electrical World*, has severed his connection with that institution. He will now devote his attention to expert accounting for which his experience and fidelity give him superior qualifications. His familiarity with electrical matters also recommends him strongly to electrical companies and concerns. Mr. McCarthy has opened offices at 114 Nassau street, this city.

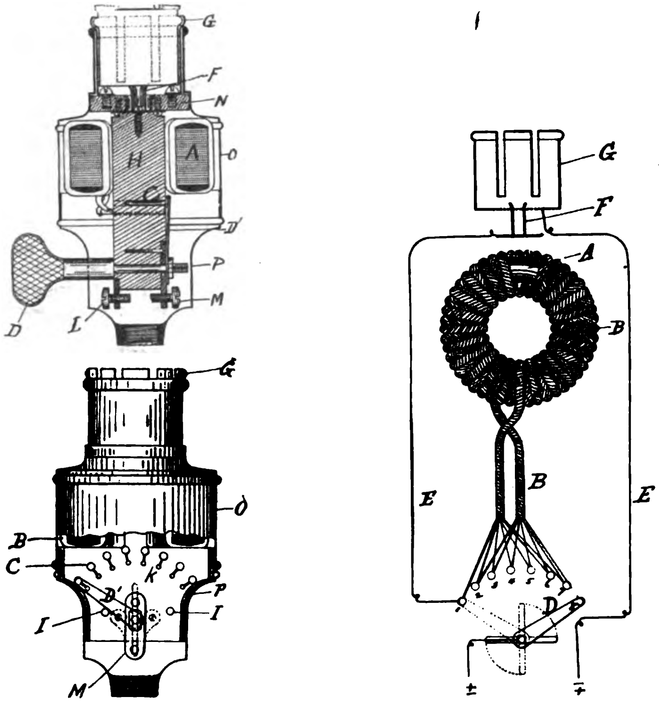
Patent Notes.

THE RIES REGULATING SOCKET.

THE recent issue of patent No. 470,402, March 8, 1892 regulating socket holder for incandescent lamp, to Elias E. Ries and W. S. Horry, and assigned to the Ries Electric Specialty Co., of Baltimore, covering some of the later features of their new regulating socket, enables us to place before our readers a detailed description of the socket that will show how the regulation of the light is effected, and how admirably the socket is adapted to the purpose for which it has been designed. The accompanying illustrations explain the construction of the socket. Fig. 1 is a sectional elevation, Fig. 2 a side elevation with part of enclosing shell broken away, and Fig. 3 a diagram view showing the coil and circuit connections.

As will be seen, the socket comprises a finely laminated iron ring A, wrapped at one operation with a cable, B, composed of a number of well-insulated copper wires, the ends of which are brought to a row of contact pins, C, arranged in the path of an arm, D, connected to the operating key, in such a manner that all of the wires of the cable are, by means of these pins, connected in series with each other and with the lamp. The coil thus formed is mounted upon an insulating block H, contained within the enclosing shell, to which block are likewise secured the lamp-holding contacts, the operating key and the binding screws L M to which the leading-in wires are attached.

The amount of counter E. M. F. force generated by this socket varies according to the position of the operating key and its arm. The coil is so arranged that when the arm D′ is removed from its open-circuit position at the extreme right and rests upon contact No. 7, Fig. 3, all of the winding B is in circuit with the lamp. In this position the counter E. M. F. generated by the coil is greatest, so that only a small portion of the applied E. M. F., sufficient to just render the lamp filament visible in the dark, is permitted to pass to the lamp. As the arm D′ is moved toward the left over the series of contact pins C, it cuts out successive sections of the winding B, thereby reducing the length of wire subjected to the inductive action of the core A, and correspondingly increasing the amount of light given by the lamp, until when the arm finally rests upon contact No. 1, practically all of the coil sections are cut out and the lamp burns at its greatest brilliancy. In some cases the coil is arranged to generate a counter E. M. F. that is nominally almost equal to and balances the direct E. M. F.; in which case the light is extinguished without the necessity of opening the circuit in which it is placed. This latter arrangement practically introduces a new system of electric lighting in which the lamp filament is at all times subjected to two opposing electromotive forces, one being variable with respect to the other, the light produced being due to the difference of potential between the two electromotive forces as determined by the position of the operating key of the socket.



FIGS. 1, 2 AND 3.—THE RIES REGULATING SOCKET.

The construction of the socket is such that it will take lamps of any voltage up to the normal voltage of the supply circuit, or of any candle power up to its rated capacity, and at the same time regulate the brilliancy of the lamp from a fraction of a single candle power up to the full capacity of the lamp, the current not used in the production of light being returned to the circuit, instead of being wasted in the development of heat as occurs when resistances are used for controlling the flow of current to the lamp or other translating device.

The patent just issued relates more particularly to the peculiar winding employed, and is in the nature of an improvement upon certain generic inventions of Mr. Elias E. Ries, for which patent applications are pending, and relating to the same subject. A number of modifications are described involving the use of special methods of construction.

A DEPREZ-CARPENTIER PATENT ON ALTERNATE CURRENT DISTRIBUTION.

ON March 15, 1892, a patent was issued to Marcel Deprez, as assignee of himself and Jules Carpentier, of Paris, for Improvements in Transmission of Electrical Energy. The claims of this patent are of the broadest possible character, and cover in terms every method of electrical distribution for electric lighting and power now in practical use in which alternating currents and transformers are employed in any way. The patent has four claims, but the nature and scope of the patent are perhaps sufficiently set forth in the fourth claim, which reads as follows:

> "The improvement in the art of transmitting electrical energy to and utilizing it at a distance from its source, which consists in generating *maintained and practically uniform* alternating currents of high tension at one station, and sending the same over a line of conductors to another station, generating maintained and practically uniform alternating currents of lower tension at the second station by the inductive influence of the high-tension currents, and converting these maintained low-tension alternating currents into other forms of energy, such as heat, light, etc., substantially as described."

The issue of this patent is the result of a decision rendered by Commissioner Mitchell on July 31, 1891, in reference to an interference which had been pending for some years between the applications of Deprez and Carpentier, Alexander Bernstein and Rudolph M. Hunter, and the well-known Westinghouse patent of Gaulard & Gibbs. Deprez and Carpentier relied for their date upon a disclosure of their invention contained in a French patent (No. 142,140 of April 5, 1881), and the decision of Commissioner Mitchell was to the effect that if their invention, when limited to what was set forth in the French patent, contained any subject-matter patentable over the prior art, their right to a patent could be in no way affected by the patent subsequently issued to Gaulard & Gibbs. Presumably, therefore, the examiners of the Patent Office have reached the conclusion that the subject-matter of the present patent contains nothing not disclosed in the French patent of April 5, 1881, and that there was nothing known in the art at that date anticipating the claims.

In our issue of September 30, 1891 (Vol. XII, p. 386), we referred to a patent which had just been granted to R. M. Hunter for the method of transmitting electric energy, consisting in generating by induction currents of low intensity, converting them by induction into currents of high intensity, transmitting these over a line to a distant point, and reconverting them by induction into currents of low intensity. It will be observed that this patent of Hunter does not cover the method of alternating distribution in ordinary use, but only a particular special application of it, which has been made with success at the Frankfort Exhibition and elsewhere, in the transmission of power to a distance. The present patent covers much broader ground than this, inasmuch as it specifically embraces the generation of high tension currents by any means whatever, whether direct, as is now done in the alternating lighting systems, or by means of a step-up transformer as used in power transmission.

It will be a matter of much speculation in electrical circles as to what view the courts are likely to take of this patent. The apparatus shown and described by Deprez and Carpentier comprises, at the transmitting end, an ordinary Page induction-coil actuated by a battery and a vibrating electromagnetic circuit breaker, while the apparatus at the receiving end consists of a similar induction coil with its connections reversed, and having in its thick-wire circuit a piece of incandescent platinum wire, being the organization described in the French patent. It scarcely needs to be said that such an apparatus does not possess the slightest practical utility for any commercial purpose to-day except, possibly, as a gas-lighter. Under the provisions of our patent law, this patent, in any event, must expire at the end of fourteen years from the date of the French patent, which will be on April 5, 1895. We note another somewhat singular circumstance in connection with this patent. The United States statute provides that no patent can be granted for an invention which has been more than two years in public use. The first electric lighting plant on the alternating system put in commercial operation in this country was that of the Westinghouse Company in Buffalo, which to the best of our recollection started on the 30th of November, 1886. The application for the patent of Deprez and Carpentier was filed November 27, 1888, thus narrowly missing, by three days, being barred by the statutory limitation relating to public use. Another interesting point arises in connection with the French patent of Maiche for a system of telegraphy, dated September 15, 1880, some six months prior to Deprez and Carpentier's French patent, relied on as the date of their invention, in which precisely the same combination of circuits and apparatus is applied to telegraphic purposes, being adapted thereto by the addition of a key in the primary circuit at the transmitting station, by which the continuous series of vibrations is broken up into dots and dashes for Morse transmission. The anticipatory effect of Maiche's patent is apparently avoided in the Deprez claim, by the insertion of the qualifying words "maintained and practically uniform alternating currents," but whether this qualification will suffice to make the claim tenable remains to be seen.

It is understood that this patent is owned by a powerful syndicate of European capitalists, and if this is really the case, further interesting developments may doubtless be looked for at no distant date.

MR. FREDERIC NICHOLLS, of Toronto, delivered an address before the Architectural Guild of that city, last week, on "Interior Wiring."

Legal Notes.

SUING UNDER THE HENRY RAILWAY PATENTS.

A BILL of complaint has been entered in the United States Court for the Northern District of New York seeking to enjoin the operation of the Troy and Lansingburg Electric Road and recover damages from that company and its officers for infringement of patents 345,845 and 424,298 granted to John C. Henry. The patents in controversy cover the entire trolley system exclusive of motors and dynamos. Knight Brothers, of Temple Court, this city, are solicitors for the plaintiff.

In patent 424,298, claim 1 refers to the span wire construction where the trolley wires are supported over the street by insulators and span wires to poles at the sides of the street. Claims 6 and 8 cover the overhead trolley wires supported by suspension from transverse guy wires and a trolley held by spring pressure against the sides and bottom of the trolley wire.

In patent 345,845 claim 4 refers to the electrical distribution wherein separate wires are used over each track, they being coupled together electrically and supplied from the same source. Claim 5 covers the combination of insulated feed wires connected at intervals to the suspended trolley wires. Claim 10 covers all forms of insulators having openings or passageways for the trolley through them. Claims 14 and 15 relate to the curve construction where the trolley wires are arranged to describe the curve of the track and are held there by guy wires from their top or side to poles at the side of street.

"THE GENERAL ELECTRIC CO."

THE above name appears to have been selected for the Edison-Thomson-Houston consolidation, as intimated some weeks ago in THE ELECTRICAL ENGINEER; and a bill has been introduced in the New York Legislature incorporating the new company, with special privileges and powers. If a liberal charter is not granted, the company will go to New Jersey for incorporation.

Letters to the Editor.

THE WESTON VOLTMETER.

THE remarks of Mr. Evershed, quoted by you on page 291 of THE ELECTRICAL ENGINEER of March 16, in reference to Mr. Weston's instruments, ought not to pass without comment. He says that "they are only d'Arsonval galvanometers, in which the current is led in by the phosphor bronze hair-springs which also act as the controlling force." The feature of a skeleton coil traversed by the current, delicately suspended in a strong permanent magnetic field, is common, it is true, not only to the Weston and d'Arsonval galvanometers, but to the syphon recorder of Thomson as well. But the d'Arsonval galvanometer, like the Thomson mirror, strictly speaking, is adapted only to measurements by zero methods, its deflections not being proportional to the values of the current except through a very limited range. I conceive that the merit of Mr. Weston's apparatus, consists, among other things, in so modifying the relation of the field to the moving coil, that the action is proportional through a large range, thus adapting the principle of Thomson's coil to the requirements of an accurate direct-reading instrument.

FRANKLIN L. POPE.

MARCH 18, 1892.

WHAT AN ELECTRICAL ENGINEER SHOULD BE.

IN THE ELECTRICAL ENGINEER of February 18, Prof. Francis B. Crocker briefly discusses the question as to whether an electrical engineer should be chiefly mechanical or chiefly electrical; and his opinion is that the electrical engineer must be an electrical specialist and that mechanical engineering, though a necessary part of his preparation, is nevertheless merely incidental.

I do not hesitate to say that there are a good many electrical engineers who will take exceptions to this view. I have a wide acquaintance with electrical engineers in this country, and this acquaintance teaches me that the most successful electrical engineers are those who are the best equipped in mechanical engineering. As I look at it there is a wide difference between the electrician and the electrical engineer. The former is the man who is interested in experimental work, in the advance of the science of electricity, in the design of apparatus, etc., while the latter is the man who is interested in the operation of apparatus, in its installation, in its practical, commercial use or development. A man may be a perfectly good electrical engineer, one who could handle great equipments successfully, and yet may fail as an electrician utterly. I could easily mention cases. And on the other hand, a man may be a brilliant electrician, one whose laboratory work excites admiration, and yet be a complete failure in what an electrical engineer would call "field work."

Prof. Crocker rather discussed what electrical engineers *are*, I think, than what they *should be*. Although I do not go so far as to say that an electrical engineer should be "nine-tenths mechanical and one-tenth electrical," yet most electrical engineers will, I think, agree that this view is nearer true than the opposite one. Perhaps it might be still nearer true to say that he should be ten-tenths electrical and ten-tenths mechanical.

With regard to *electricians* the case is different, though here also, I believe, a man must be largely mechanical to be successful. I heard Prof. Elihu Thomson say once, when speaking of a good draughtsman, who was an unsuccessful electrical apparatus designer, that the man "did not seem to see the current going through those secondaries." Unquestionably, a man should be more an electrical than mechanical to be a successful electrician. But if any one will search through the laboratories and electrical factories of the country he will find that the most successful electricians are the men who have had a thorough mechanical training. And in my opinion, the one great reason why the Crocker-Wheeler motor, for instance, has taken its present high position in the market, is because its mechanical details have been worked out with such care and ability.

OTIS K. STUART.

PHILADELPHIA.

TRANSMISSION AT ONE MILLION VOLTS.

IN you issue of March 9, under the heading, "Transmission at One Million Volts," appears an article which sounds absurdly funny. The writer informs us that it is customary in central arc lighting stations to connect constant current machines in series· Now since this practice is followed to a *limited extent*, Mr. Dorman proposes, and sees no obstacle in the way of carrying it to an *unlimited extent*.

I have had considerable experience with constant current machines, and have always found, that a machine had to be *very* carefully insulated to stand a strain of from 3,000 to 4,000 volts.

Now Mr. Dorman has carefully informed us how to insulate the conductors on the line for a pressure of 1,000,000 volts or even, as he says, 2,000,000 or 3,000,000 volts (the feasibility of which I question). But after stating his intention of describing his generating machinery, he simply says that he uses constant current machines, neglecting to tell us anything about the insulation of dynamo or motor.

Surely this is a question of vital importance, and I would be very glad if Mr. Dorman would give us a little more information in detail of a dynamo which would stand the voltage of which he speaks.

CHAS. N. PEAKE.

LYNN, MASS.

A NEW FORMULA.

IN view of the Thomson-Houston-Edison consolidation, and in view of the proposed consolidation of the Edison Association with the National Electric Light Association, it has occurred to me that the latter should have a new badge, to replace the old one of $C = \frac{E}{R}$ by the following, $E = \frac{T}{H}$.

W. T.

Society and Club Notes.

NEW YORK ELECTRIC CLUB.

THE following important circular has been sent to all the active and associate members of the New York Electric club. It is to be hoped and expected that the members will respond promptly and unanimously to this appeal. We happen to know that the past and present management of the club, with a few of its friends, have done all that is possible to meet the contingency when it has arisen in critical shape, but no board can be exected to assume and meet such burdens indefinitely. It is a question for the membership and for the membership alone.

> The Board of Managers have for some time past had under consideration the finances of the club. They have found that the income is insufficient to meet current liabilities. The club has been running behind upwards of $3,000 per year; which is mainly due to the expense of running the café, and to lack of support by the members.
>
> In order to bring the expenses within the income of the club, the Board of Managers, at a recent meeting, decided to close the café temporarily, and to run the bar, billiard-room and sleeping-rooms of the club on a strictly cash basis. The expense of running the club under these conditions will, it is believed, be within the income. It now remains to provide for the indebtedness previously incurred, amounting to $8,000 exclusive of the bonded debt.
>
> To provide for the current debt the Board of Managers, at its meeting, March 17, passed a resolution to assess the members of the club as follows:

Active members	$30 each.
Associate members	15 "

To meet the present demand it will be necessary that a check from each member be received by the Treasurer not later than Thursday, March 31, 1892, and it is hoped that every member, active and associate, will recognize the importance of prompt attention to this request; inasmuch as the continuance of the club and the retention of its club house depend upon the prompt collection of this assessment.

If the requisite response be given to this assessment it is believed that the club has before it a prosperous future.

By order of the Board of Managers.

SAMUEL INSULL,
President.
GEO. M. PHELPS,
Treasurer.
STEPHEN L. COLES,
Secretary.

NEW YORK ELECTRICAL SOCIETY.

THE next regular meeting of this society will be held in Prof. Chandler's lecture-room at Columbia College on Friday, March 25, at 8 p. m. Prof. F. B. Crocker will deliver a lecture on "Electrical Measuring Instruments," in which he will demonstrate the principles of construction of the most important instruments for the measurement of continuous and alternating currents, and will illustrate their use in actual practice by the aid of the large collection of instruments belonging to Columbia College.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the meeting of Council, held March 15, the following gentlemen were elected to associate membership:

Aldrich, William S., associate in mechanical engineering in the department of electrical engineering, Johns Hopkins University, Baltimore, Md.

Blakeney, W. H., firm of Blakeney & Reume, mechanical and electrical engineers, 33 Bath street, Glasgow, Scotland.

Carroll, Dwight F., instructor in electrical engineering, Lehigh University, South Bethlehem, Pa.

Lenz, Charles Otto, draughtsman (electrical), Edison General Electric Co., box 3,067, New York City.

Martin, A. J., general superintendent, West End Electric Company, 1310 N. 29th street, Philadelphia, Pa.

Perot, L. Knowles, consulting electrical engineer, 308 Walnut street, Philadelphia, Pa.

Sachs, Joseph, electrician, the American Engineering Company, 109 World Building; residence, 1839 Lexington avenue, New York City.

Wessels, Edward J., New York agent, the Short Electric Railway Company, 121 World Building, New York City.

The annual meeting for the election of officers, the reception of yearly reports and the transaction of business will be held at the headquarters of the Institute; in New York City, on Tuesday, May 17, followed by a dinner in the evening.

The general meeting for the reading and discussion of professional papers will be held at Chicago on Monday and Tuesday, the 6th and 7th of June. The programme of papers is now in preparation, and full particulars will be given out as soon as possible.

POLYTECHNIC SECTION, AMERICAN INSTITUTE—MR. SCHIEREN ON LEATHER BELTING.

AT the meeting of the Polytechnic Section of the American Institute of New York, on Thursday evening, March 17, Mr. Chas. A. Schieren read a paper on the "Art of Tanning Leather and Making Belting." He showed in the lecture the various processes through which a hide passes in the tannery, which were all beautifully illustrated by lantern slides. The various departments through which the hide passes in the tannery, the machinery used for manipulating the leather, as well as the grinding and leaching of the bark, were illustrated and thrown on a large canvas by lantern slides. This made the lecture doubly interesting because the audience could get a clearer idea of the manipulation of leather in the tannery.

In the making of belting Mr. Schieren showed a hide of leather from which were taken four pieces of equal length and width; they had been submitted to a test by a powerful testing machine of the Fairbanks Scale Co., of New York. These pieces were all eighteen inches long, and two inches wide, and were numbered. Number three, being cut from the lower part of the centre, broke at 2,490 pounds strain, which would give the piece a transverse strength of 14,940 pounds per square foot. Number four, cut from the upper part of the centre of the hide, broke at 2,000 pounds. Number five, cut from the lower part of a shoulder piece, broke at 1,390 pounds. Number six, cut from the upper part of a shoulder, broke at 1,130 pounds.

The lecturer explained that very many belts were sold and offered in the market which were made from one piece of centre on one side, and a piece of shoulder on the other side. He clearly proved that such belts were defective because of the shoulder being so much more liable to stretch, and not being able to withstand the strain of a centre piece by at least forty-three per cent. it would be a serious mistake to put the two pieces together for transmission of power, on account of the unequal tension. A belt would be superior if two shoulders were used, or two centre pieces, separately. He claimed that a belt made from two centres could withstand a transverse strain of nearly 26,940 pounds to the square foot, whereas, a belt made from shoulders would hardly stand 15,120 pounds strain, and such belts would not be reliable, especially on dynamos, or swift running machinery, in fact, for almost any drive where a belt is subjected to severe train.

PROF. A. G. BELL AND THE ELECTRICAL ENGINEERS.

As president of the American Institute of Electrical Engineers, Prof. Alex. Graham Bell has promised to deliver a lecture before that body some time in April—probably the 19th. It is understood that his subject will be "Radiophony," a theme full of interest, and one that, as far as we are aware, has never been brought before a New York audience. It is expected that the lecture will be delivered at Columbia College, and that, as usual, on these special occasions, ladies will be present. In view of the large attendance at these gatherings, admission will be by card. Due announcement as to details will be given later on.

CHICAGO ELECTRIC CLUB.

THE CHICAGO ELECTRIC CLUB have arranged for a series of papers on subjects connected with the electric railway, as follows:

March 21. One Motor for Car Equipment.
Two Motors for Car Equipment.
March 28. The Gearless Motor.
The Single Reduction Motor.
April 4. Debate, "Resolved, We Should Have the Trolley System in Chicago."

OHIO GAS-LIGHT ASSOCIATION.

THE OHIO GAS-LIGHT ASSOCIATION, 150 members present, have endorsed the action of Eastern gas associations in resolving to use their influence to prevent the five-million-dollar Government loan to the World's Fair unless the World's Fair Commission deals more fairly with the gas people.

They claim that the commission has set apart a million and a half dollars to make an electric light display and not a dollar for a gas-light exhibit. Worse than this, the location of the Gas-Light Building, built at private expense, is in an out-of-the-way place.

SOUTHEASTERN TARIFF ASSOCIATION.

AT the meeting last week of the S. E. T. A. in Washington, the following resolutions relating to electrical work were adopted:

Resolved: That the basis rates of electric light and power houses in first-class cities be 1 per cent., and in other cities remain as they are.

Resolved: That the Executive Committee shall insist on perfect insulation of electric wires, and that an extra charge be made where wires are not in conduits.

Resolved: That the Executive Committee co-operate with the Atlanta Fire Department in its present system of inspecting buildings, and if necessary, appoint an electrical expert whose salary shall not exceed $100 a month.

Obituary.

C. J. VAN DEPOELE.

CHARLES J. VAN DEPOELE, one of the first to adapt electricity to the work of mining and electric railroading, died on March 18, at Lynn, Mass. He was forty-six years old.

Mr. Van Depoele was born in Belgium, and at an early age displayed great interest in machinery and in electrical matters, but his parents discouraged his investigations in this line and apprenticed him to the cabinet-making trade. Going to Detroit in 1869, he began the manufacture of art furniture, and from that time on for several years he spent all of his leisure and much of his revenue from the furniture business in electrical experiments. In 1877 he built an electrical laboratory, and there constructed several large dynamos, with which exhibitions were given. In 1878 he lit up Forepaugh's circus, and after that Recreation Park was illuminated nightly for the benefit of the baseball enthusiasts. A great hobby of his was the propulsion of cars by electricity, in which his first experiments were made in 1882. His first commercial road was equipped in 1885 at South Bend, Ind. He had also a great interest in telpherage. In the spring of 1888 the Van Depoele Company sold out to the Thomson-Houston Electric Company of Boston, whose service Mr. Van Depoele thereupon entered as electrician of the railway department. A fine portrait of Mr. Van Depoele and full biographical sketch of him will be found in THE ELECTRICAL ENGINEER of June 25, 1890.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The feeling of readers toward a paper determines the action of the advertisers in it.

QUEEN & CO.

It is not often that electrical companies announce "bargain days" or "annual spring sales" but an interesting circular just received would indicate that Queen & Co. have decided that old stock is worse than none, and the way they have cut the prices of some ammeters and voltmeters is something heretofore unknown in the instrument business. This startling reduction of course does not apply to any of their regular stock, but they happen to have on hand a good many Ayrton & Perry spring ammeters and voltmeters which do not find so ready a sale now as formerly, for obvious reasons explained in the circular from which we quote:

"When these ammeters and voltmeters were first placed on the market some five years ago, they were without doubt the best instruments made for both experimental and practical measurements. Their points of excellence were and still are portability, absence of permanent magnets; constancy; and direct reading proportional scales. As a consequence we have supplied them to most of the large manufacturing companies, to many central stations, and to the principal college laboratories. Recently we have engaged extensively in the manufacture of ammeters and voltmeters for all purposes, and find that for exact work we can produce instruments of greater accuracy, and for station use of equal accuracy at a less cost than the Ayrton and Perry type.

"We have decided, in consequence, to insure a prompt disposal of the instruments of this make still on our shelves, and have reduced their prices *fifty per cent.* from last year. This reduction is made without regard to cost, and it is a rare opportunity to obtain a good ammeter or voltmeter for experimental or every-day use, at a marvelously low figure."

Everybody is familiar with this type of instrument and those wishing to take advantage of an exceptional opportunity should send to Queen & Co. for a copy of circular No. 275.

THOMSON-HOUSTON ELECTRIC ELEVATORS.

Although the use of electricity as a motive power for freight and passenger elevators is of comparatively recent date, the Thomson-Houston Motor Company has devoted much time and thought to the perfection of apparatus for this purpose.

The first cost of an electric elevator installation is very much in its favor, as the electric motor takes the place of the steam plant. The cost of current for the motor is no more than the cost of coal for the steam plant, and with the use of the electric current come none of the disagreeable features—heat, dust, ashes, etc.—which are necessary attendants upon the use of coal. With the hydraulic elevator as much water is required to lift one person as for a full load, while with the electric elevator the power used is in direct proportion to the weight being raised.

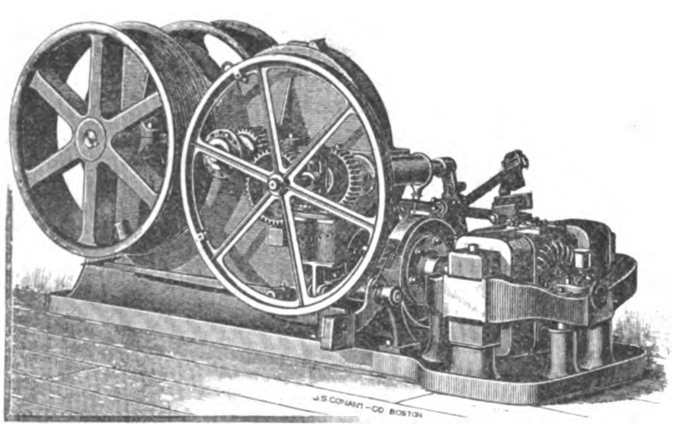


Fig. 1.—Thomson-Houston Reversible Elevator Motor.

The Thomson-Houston apparatus can be easily applied to steam and hydraulic elevators already installed. Where elevators are operated by counter-shaft and belt machines, such as are in general use for freight work, a reversible elevator motor is attached by gears directly to the machines, as shown in Fig. 1, and the electric switch and rheostat connected to present hand-operating cables, the motor starting, stopping and reversing simultaneously with the car, thus using power only when the car is in motion, and then using only sufficient power to lift the actual load in the car.

For a steam pump operating an hydraulic elevator an electric pump of like capacity is substituted, which runs only when pressure is lowered by the upward movement of the car, and is automatically stopped when pressure reaches the maximum. Instead of operating by city pressure, an electric pump can be installed to force the water directly into the hydraulic cylinder, or for supplying a pressure or roof tank, from which the elevator is operated.

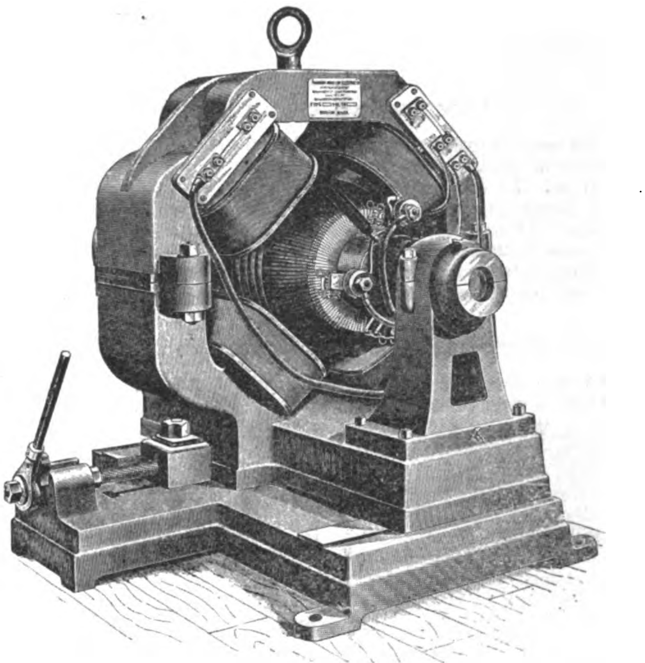


Fig. 2.—Thomson-Houston Multipolar Elevator Motor.

The illustration, Fig. 2, shows the type of large Thomson-Houston motor, especially adapted to elevator work. It is of the multipolar type, having four poles and a Gramme ring armature. This construction renders possible a very slow speed and a very large output for the size of the machine. The one shown is of 110 h. p., and runs at a speed of only 700 revolutions. The commutator has a large number of segments, and the current is collected by four sets of carbon brushes which bear radially upon the commutator. The machine is equipped with self-oiling bearings, and in general design is the same as the Thomson-Houston multipolar generator, which is now being so extensively used and which is giving such general satisfaction in railway power stations.

THE TORONTO AND MIMICO ELECTRIC RAILWAY.

The Reliance Electric Manufacturing Company, of Waterford, Ont., who are building the Rae system in Canada have secured the contract for the equipment of the Toronto and Mimico Electric Railway. This road will start from the terminus of the Toronto City Railway Company's lines on Queen street and extend to the village of Mimico and eventually to Long Branch, a total distance of about seven miles. The road runs along the lake shore the entire distance. The Reliance Company have the contract for the entire equipment exclusive of track. The power station will contain one Armington & Sims engine of the compound condensing type, 125 h. p., and the Rae station electrical apparatus consisting of one 85 K. W. generator and necessary appliances. The motors for this road are of Mr. Rae's latest design of single reduction motors, which are at present only built in Canada.

THE CLARK ELECTRIC CO.

The above company, of 192 Broadway, New York, have published a very interesting and artistic pamphlet on their system of arc lighting, which they characterize as "the cheapest illumination in the world." It is well illustrated with their apparatus, and details are given as to each feature. Several of the medals won by the system are shown, printed in bronze inks. Special reference is made to the Clark search light and Clark projection arc light, both excellent pieces of mechanism. Of the latter we can speak in very strong praise, its use at the headquarters of the Mechanical and Electrical Engineers having been most satisfactory.

THE "KNOWLES" ARC LAMP FOR ALL CIRCUITS.

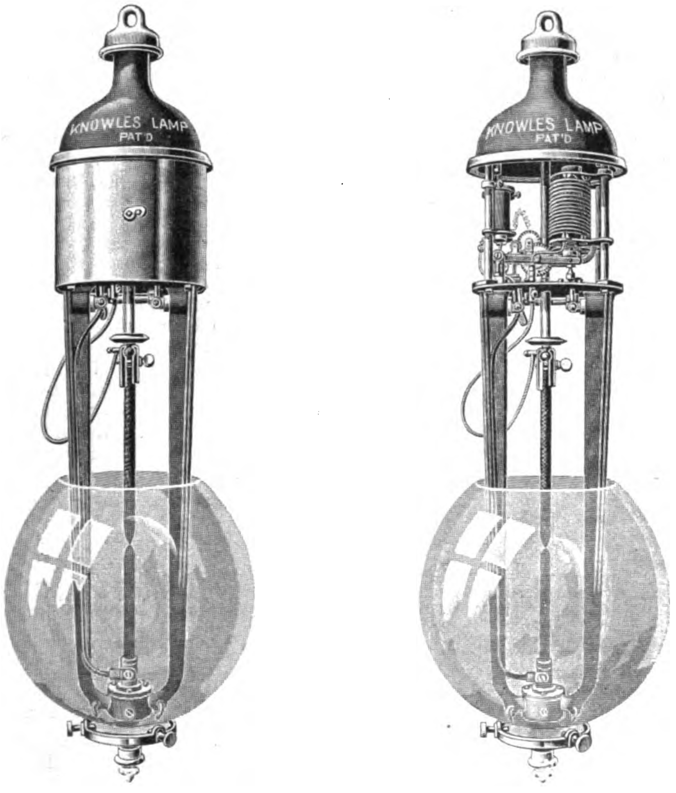
A PRACTICALLY perfect system of electric lighting should be of such a character that any desired kind of lamp, either arc or incandescent can be run from a single system of wiring, thus obviating the necessity and expense of providing a separate system of conductors for each kind of lamp. At the present time by far the largest portion of all electric lighting is by means of the incandescent lamp, and but few of the many installations of this character use any kind of light other than the incandescent. In a great many instances the best and most satisfactory lighting would be obtained by the use of a much more powerful light, such as the arc lamp.

A practically perfect arc lamp for use on incandescent circuits should embody the following essential features; it should be neat in appearance, compact and of light weight; dust and weather proof; well ventilated; simple and accurate in construction; perfect in regulation; noiseless in running; non-differential in action (no pumping) and be perfectly insulated. It should also be capable of burning for at least ten hours with a single pair of carbons and without retrimming and it should be low in cost.

The "Knowles" lamp is intended to fill all these requirements as nearly as it is possible to do so. The lamp is practically a universal lamp working equally well upon a constant current or constant potential circuit or alternating current circuit. It runs at any voltage and any current and is a radical departure in its construction from all existing types of arc lamps.

Its general construction may be seen in the accompanying illustrations, Fig. 1, showing the lamp complete and ready for use and Fig. 2 showing the lamp with the case removed so that the working mechanism may be seen.

Its length is 40 inches over all and its weight, 20 pounds. It is neat in appearance and compact in construction. There is no projecting horn on the top of the lamp and no projecting globe-holding tube on the bottom and no unsightly projecting binding posts. It is so designed that it may be hung close up to the ceiling of a room and its length is such, that, even in a low-studded room, it will be clear of the heads of persons passing beneath it, thus obviating the necessity for making holes in the ceiling so that it can be hung high enough up to be out of the way. Its feed movement is very simple and accurate in construction and operation and not liable to get out of order. The lamp case is dust and weather poof and can easily be removed while the lamp is in operation, and the lamp is ventilated in such a manner that any heat generated in the magnet coils is rapidly carried away and dissipated. The dust and weather proof character of the lamp enables it to be used out of doors without the necessity of its being covered by a protecting hood or canopy. There are only two pieces of insulation in the lamp and these are of a material which is non-combustible and not affected by moisture.



FIGS. 1 AND 2.—THE "KNOWLES" ARC LAMP.

The lamp is non-differential in its character, its feed being positive in its action, and free from all pumping or jiggling. The lamp operates normally at about 50 volts pressure and at a current of from 6½ to 7 amperes. It will run two in series on a 110-volt circuit, or as many in series of any circuit as the circuit pressure is a multiple of 50 volts. The lamp will run on any desired current from 5 to 10 amperes and when once adjusted needs no alteration of adjustment for any variation of current between these limits.

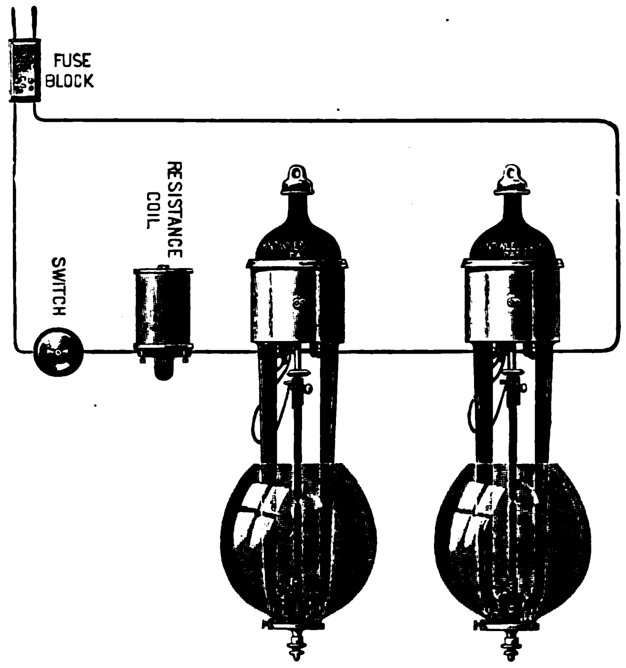


FIG. 3.—THE "KNOWLES" ARC LAMP.

The lamp when trimmed with a proper size and kind of carbon will burn at a current of from 6½ to 7 amperes and at 50 volts pressure for about 12 hours thus making it a practical all-night single-carbon lamp. The lamp is noiseless in running, and gives a pure white steady light with no flickering, hissing or sputtering, resembling closely in appearance a very large incandescent lamp.

Fig. 3 shows the manner of connecting and arranging the lamps when two are run in series upon a 110-volt circuit, the diagram is the same for other combinations of lamps, as, for example, when four run in series upon a 220-volt circuit or 10 in series upon a 500-volt circuit merely substituting the required number of lamps for the two shown.

The lamp is provided with a ceiling hanger-board when used indoors and with a substitute resistance equal to that of the lamp when more than two are run in series upon a constant potential circuit and with an automatic cut-out when run in series upon a constant current circuit.

This lamp was invented and patented by Edward R. Knowles, chief electrician of the Schuyler Electric Company, of Middletown, and has been adopted by the Thomson-Houston Electric Company, for all their offices.

E. W. WILSON & CO.

MESSRS. E. W. WILSON & Co. have just opened offices at No. 96 Broadway, where they propose to carry on a general banking business, including the purchase and sale of all securities dealt in on the New York Stock Exchange. The members of the firm are Mr. Edward W. Wilson and Mr. Archd. A. Watson. Mr. Wilson has been actively engaged in the electrical line, handling the securities of electric lighting and kindred companies, especially those associated with Thomson-Houston interests. Mr. Watson was formerly for five years of the firm of Watson Bros., now dissolved. He is a member of the New York Stock Exchange and represents the interests of the house on the floor of that institution. They will make a special feature of the handling of investment securities and the purchase and sale of the controlling interest of the stocks of electric lighting and street railroad companies' property. Mr. Wilson has already scored some considerable successes in this field.

ANNUAL MEETING OF THE BRUSH ELECTRIC CO.

THE annual meeting of the Brush Electric Company was held at the office of the company on March 15. The following directors for the ensuing year were elected: S. A. Barton, Boston; J. S. Bartlett, Boston; Myron T. Herrick, Cleveland; J. Potter, Cleveland; C. A. Coffin, Boston; William B. Bolton, Cleveland; S. M. Hamill, Cleveland.

Immediately after the stockholders' meeting the new board of directors met and elected the following officers: S. A. Barton, president, Boston; John S. Bartlett, first vice-president, Boston; C. A. Coffin, second vice-president, Boston; S. M. Hamill, secretary; L. B. Le Vake, assistant secretary; J. Potter, treasurer; A. H. Hough, assistant treasurer; William B. Bolton, general counsel; J. B. Hughes, auditor; S. H. Short, general electrician; F. A. Scheffler, superintendent; C. W. Phipps, assistant superintendent; S. M. Hamill, general manager—all of Cleveland.

Advisory Committee—J. Potter, William B. Bolton, S. M. Hamill.

Manufacturing Committee—S. H. Short, F. A. Scheffler, S. M. Hamill.

THE HOTEL BRIGHTON ISOLATED PLANT AT ATLANTIC CITY.

MR. FREDERICK HEMSLEY, the owner of the Hotel Brighton, has just completed extensive alterations and additions to this well-known house. As it has not been closed for over seven years this was the first opportunity that offered for the introduction of the electric light.

After obtaining a number of proposals from the electric light companies for the equipment the owner decided to place the matter in the hands of a consulting engineer, and Dr. W. A. Drysdale, of Philadelphia, was selected and instructed to have the entire installation completed in time for the opening, a period of 30 days. The time allowed was extremely limited, as specifications, plans, drawings, estimates and contracts, as well as the actual construction, had to be completed within this time.

The hotel building was wired for 650 lights, in addition to some 50 lights distributed in the help's quarters, engine-room, etc., making in all some 700 lights. The highest class of construction was insisted upon throughout the entire installation; the majority of these lights were placed in rooms requiring one or two lamps, and all material had to be obtained outside of Atlantic City. There was very little delay in the prosecution of the work, owing to the complete arrangements made, and on the afternoon of the thirtieth day the entire installation, including steam plant and dynamos, was ready for operation and after satisfactory tests had been made was accepted for the owner by the consulting engineer.

Much credit is due the contractors for the thoroughness of the work and the manner in which the spirit of the instructions of the consulting engineer were carried out.

The United States Electric Lighting Co. were awarded the contract for the dynamos, wiring and electrical equipment, the Stearns Manufacturing Company, of Erie, for the engines, the Horn, Brannen & Forsyth Manufacturing Company, of Philadelphia, for the fixtures, and Mr. John F. Trachsel, of Philadelphia, for the piping.

WASHINGTON, PA., ELECTRIC LIGHT AND POWER CO.

WASHINGTON, PA., has been the scene of an electrical development worthy of a town twice its size. The plant of the Washington Electric Light and Power Co. is now installed in a fine brick building 110 by 37 feet. It comprises one Fort Wayne alternating dynamo of 1,300 lights; one Westinghouse alternating dynamo of 750 lights, one of 500 lights, and a Westinghouse arc machine of 60 lights. There are also two United States generators of 80 h. p. The steam plant consists of one Ball engine of 60 h. p., one Taylor of 100 h. p., and three Westinghouse compound of 100 h. p. each. Steam is furnished from three boilers of 360 h. p. total capacity, and one boiler of 60 h. p. not in use at present.

The current for the Washington Electric Railway is supplied from this plant. The road has at present five cars with two motors of 20 h. p. each. Three miles of track are in use. Both companies are doing a good business, and find the demand increasing all the time. Mr. T. R. Branner, electrician, of Washington, Pa., installed the whole plant, which is working admirably and is a credit to a live and progressive community.

EDISON CENTRAL STATION LIGHTING.

A MOST interesting and very tasteful pamphlet has been issued on "Central Station Lighting" by the Edison General Electric Company. It embraces arc as well as incandescent work, but is specially devoted to the latter, regarding which, and the three-wire system it gives a variety of most useful information. There are many fine cuts to illustrate the text. One important part of the pamphlet deals with the legal status of the lamp suits. The pamphlet is supplemented by a number of illustrations of Edison central stations, exterior and interior, and by a set of tables, units, etc. The pamphlet bears the imprint of Bartlett & Co., a fact that speaks for the high artistic quality of the work.

THE C. & C. MOTOR IN THE WEST.

THE "C. & C." ELECTRIC MOTOR COMPANY have established a branch at Chicago, where they will occupy the large ground floor store at 201 Madison street, that city. The facilities for the convenience of their customers noticed in the New York house will be found duplicated in the Chicago establishment, where the company will carry in stock all sizes of the "C. & C." motors and dynamos; also parts of same for replacing worn or broken machines Users of electric power located in the West are cordially invited to call. The intention in establishing this branch office is to extend the same privileges to purchasers in Chicago, both as respects prices and delivery of machines, that would be obtained by direct application at the company's factory in New York.

Owing to an increasing demand for their motors from that section, the "C. & C." Electric Motor Company have opened a branch establishment in Portland, Oregon. They are admirably located at 53 and 55 North Front street, where they will carry in stock all sizes and all parts of the "C. & C." motors and dynamos. Parties located in that territory having business with the company will find the Portland branch a great convenience.

NEW QUARTERS FOR THE POSTAL TELEGRAPH CO.

THE POSTAL TELEGRAPH CO. has leased property 70 by 100 at the corner of Murray street and Broadway from the Trinity Church estate, and will put up there a fine large office building. It will occupy part itself, and expects to have the best telegraphic headquarters in the country, Work will begin on the new building this summer.

A PROPOSED THIRTY-ONE MILE ELECTRIC ROAD.

MR. E. R. HOTSENPILLER, proprietor of the Park Hotel, Magnetic Bath House and grounds etc., at Magnetic Springs, O., writes us that he has formed a project for an electric railway from Columbus, O., to Magnetic Springs, a distance of thirty-one miles. Articles of incorporation are now being filed with the secretary of state, and it looks as though the road will be actively pushed.

PROF. ROWLAND'S "PERFECT SCREW."

THE *Baltimore American* recently published a description of what is known as a "perfect screw," made by Prof. Henry A. Rowland, of the Johns Hopkins University, for his wonderful dividing engines, with which he rules tens of thousands of lines to the inch, to make the "gratings" enabling scientists to study accurately the spectrum of the sun, etc. "This new and perfect screw," it says, "which has been the subject of so much experiment by the great scientist, and whose improvements are the result of the close study of certain unsatisfactory experiments, is of steel. The last one was of Bessemer steel, which it was thought, combined both the requisite softness and homogeneity. But for the new one, Jessop's tool steel, annealed at the factory, has been found to have the required fine grain and the softness, and to be far more perfectly homogeneous than those previously made. It was cut in the workshop of the physical laboratory of the Johns Hopkins, on an ordinary lathe, and thereafter ground with fine emery under water and oil maintained at a certain temperature for over three weeks." Following the above paragraph is a lengthy article about the machine, said to be capable of ruling 1,000,000 lines to the inch, and its uses for scientific purposes.

The attention of Messrs. William Jessop & Sons, of New York, was called to this voluntary compliment and they wrote to Mr. William G. Wetherall, of Baltimore, who for many years has kept the Jessop steel on sale in his warehouse, and asked if he had sold to the Johns Hopkins University the steel above mentioned. This inquiry brought the following reply:

BALTIMORE, December 29, 1891.

MESSRS. WM. JESSOP & SONS,
NEW YORK.

Dear Sirs:—

Your favor of the 28th inst. is to hand, and noted. We beg to say in reply that we sold the steel referred to in the newspaper article you enclosed (a bar 1⅛ R of your annealed steel, in August last, to the machinist who works for the Hopkins University.

We are so accustomed to having your steel turn out satisfactorily that it occasioned no remark, as only the contrary would have surprised us.

Wishing you the "Compliments of the Season," we remain,

Very truly yours,
W. G. WETHERALL."

The factory of Messrs. Jessop and Sons, Limited, is in Sheffield, England, and was established in 1793. The principal depot in the United States is at 91 John street, New York, where a full stock of all sizes of Jessop's best tool steel, annealed and unannealed, of superior quality, can always be found. Their depots and warehouses are also widely distributed throughout the world.

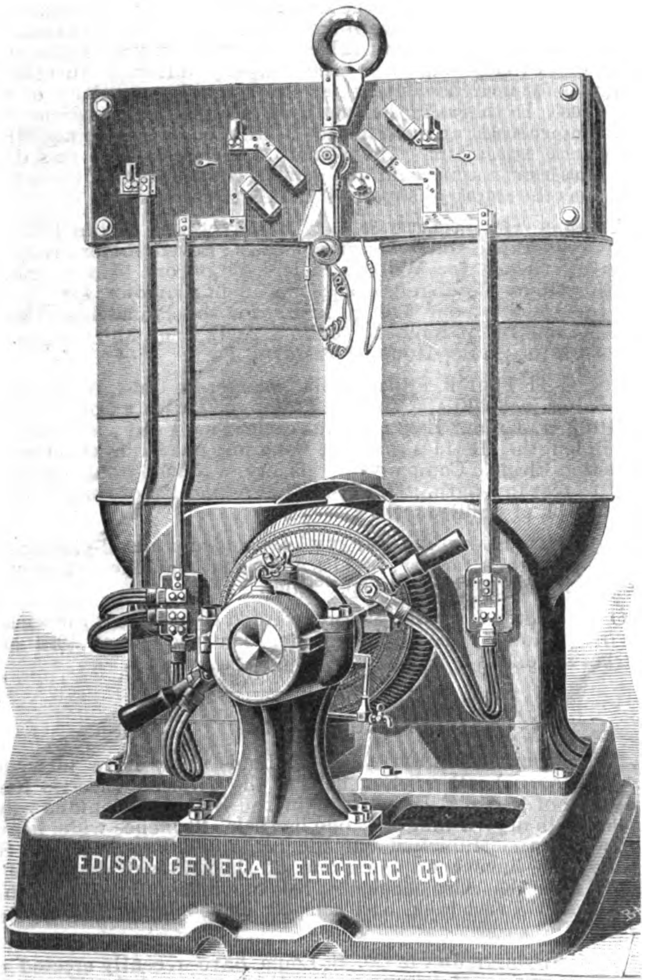
MESSRS. SUTTON & STEELE, of Dallas, have brought out a new dynamo for arc and incandescent lighting. It is said to be one of the smallest and cheapest on the market, for its output.

THE IMPROVED EDISON 200 K. W. GENERATOR.

The elimination of objectionable features from electric lighting and electric power apparatus, and the introduction of improvements is the present aim of all manufacturers of electrical devices. The accompanying illustration shows an Edison 200 kilowatt generator of the latest form illustrating this. It is of the bi-polar type, with the general features of which every practical electrician is acquainted.

The series field is built up of sections, wound on spools which are slipped over the cores and then properly connected up. Should a fault manifest itself, it can be located, and the spool in which it appears can be removed, repaired and replaced, or another substituted at once without-loss of time. Expenditure for repairs is thus reduced to a minimum.

To adapt this generator to the demands of electric railway service, the field has been provided with a compound winding, easily adjusted to meet the necessary requirements by means of a shunt coil, conveniently placed in the backboard of the keeper. The bearings being located close to the base frame, the centre of gravity of the armature is low and great stability is thus secured. Self-oiling bearings and carbon brushes contribute to diminish the necessary attention to a minimum.


EDISON GENERAL ELECTRIC CO.

The Improved Edison 200 K. W. Generator.

A considerable number of these high capacity generators have already been installed by the Edison General Electric Company throughout the country, and the advantages they offer have been duly appreciated.

MR. M. J. MARTINEZ.

This gentleman has recently associated himself with the Geo. F. Blake Manufacturing Co., of 95 and 97 Liberty street, this city, where he will take charge of the Central and South American export department. The company manufacture a large variety of pumping machinery for water-works, vacuum and boiler feed pumps, air and ammonia compressors, etc. Mr. Martinez's experience as a mechanical engineer together with his knowledge of the needs of export customers will make him a valuable acquisition to company.

NEW ENGLAND NOTES.

The Bradbury Stone Storage Battery Company, of Lowell, are making quite a success of their storage battery, and are in receipt of many of the warmest kind of testimonials regarding its work. The car which they equipped with their batteries in Sioux City, continues to give the best of satisfaction, and the street railway company are anxious to have another car equipped. They are at present making arrangements to increase their facilities for the manufacture of storage batteries, and are compiling a very interesting catalogue descriptive of the battery and containing a large number of testimonials from their customers. There is a good opportunity for an enterprising motor or car company to co-operate with the Bradbury Stone Company, in the line of pushing storage batteries for street car work.

The Electric Heat Alarm Company, of Boston, have just issued a neat little pamphlet descriptive of their system of protecting bearings from getting overheated. Their system, as already described in our columns, consists of a small cap containing mercury which is inserted in the cover of the bearings. Should the bearing get hot, the mercury expands and by making electrical contact with an alarm bell, which may be situated in any convenient place, at once warns the attendant engineer of the danger, when steps can at once be taken to prevent any damage. The pamphlet is well got up, and should be very interesting to all in charge of machinery of any kind.

The John Becker Manufacturing Company, of Fitchburg, Mass., have now got thoroughly installed in their new factory, into which they recently moved from Boston. The machinery is now all set up, and Mr. Becker reports that they have already shipped from Fitchburg several of their well-known milling machines. These machines are of special design with a very high rotary speed, and are well adapted for all kinds of electrical work. This company are also large founders of brass and bronze name plates and have a large trade with most of the electrical manufacturing companies.

The Mather Electric Company and the Perkins Electric Lamp Company have recently moved into their new and handsome offices on the top floor of 116 Bedford street, Boston, the building in which they have been located for the past two years. Their offices extend over the whole floor and are replete with every comfort and convenience to accommodate their largely increasing business. Among other features they have an excellent draughting-room, well lighted from a skylight in the top of the building, and will be able to attend to many inquiries and business matters that have hitherto been referred to Manchester.

The Holtzer-Cabot Electric Company, of Boston, have just issued a neat little pamphlet relating to the H. C. automatic motors, fan outfits, generators, plating machines and motor generators. This company have attained an enviable reputation on the quality of their varied manufactures, and in going into this heavier class of work, have adopted all that is best in motor practice, and have carefully calculated the mechanical and electrical designs, so that it is confidently expected that the H. C. motor will rapidly establish for itself a first-class reputation and will be able to compete with any on the market.

The Berlin Iron Bridge Company, of East Berlin, Conn., have taken the contract for a new boiler shop for the Dry Dock Engine Works, at Detroit, Mich. The building will be 63 feet in width by 201 feet in length and will be constructed by the Berlin Company. The building will be designed and built entirely throughout from the foundations by the Berlin Bridge Company. They not only furnish the iron work but supply the foundations, brick work, in fact, the whole building complete for the machinery.

The Thomson-Houston Electric Company have recently received the order for 360 railway motors of the W. P. 30 type for the Lynn and Boston Railway. This railway will have two stations of 5,000 horse power each, one in Lynn, near the coal wharves on Washington street and one in Chelsea near the ferry. Two M. P. 270 generators have been ordered at present, and it is expected the road will be in operation by midsummer, the work being pushed along as fast as circumstances will permit.

The Wainwright Manufacturing Company of Massachussetts, of Boston, have recently closed contracts for 16,000 horse power of their well-known heaters. These heaters are for the Lynn and Boston Electric Railway, the New York Electric Railway and the Albany Street Railway Company. This is the largest order that has ever been placed for feed-water heaters, and is a sufficient evidence of their sterling worth, and of their popularity amongst electrical engineers.

The Simplex Electrical Company, of Boston, have decided to discontinue their New York agency, hitherto held by Messrs. W. H. Gordon & Co. Until further arrangements are made Major Everts, assistant manager of the Simplex Company, will look after their interest in New York, with headquarters at the Imperial Hotel.

The Eastern Electric Supply and Construction Company, of Boston, have received the contract to build and equip complete the Worcester and Shrewsbury Electric Railway. There are at present three miles of track, which has hithertho been operated by a steam dummy, but it will soon be increased by other thirteen miles. They have also just equipped the factory of the Speare Manufacturing Company with a 200-light incandescent plant, using the Edison system.

The Eastern Electric Cable Company, of Boston, manufacturers of the famed Clark wire, have been forced to again increase their factory facilities, and have added another story to one of their buildings, which will be devoted to braiding purposes. Their business continues to increase steadily and they are now turning out fifty per cent. more wire than during the same period a year ago.

Mr. R. S. Brown, agent of the Westinghouse Electric and Manufacturing Company, has just closed a contract for six gearless motor equipments for the Waterville & Fairfield Railroad Company, Fairfield, Maine, and ten car equipments single reduction for the Boston Construction Company.

Mr. W. Roy Mitchell, as agent for the Edison General Electric Company, has closed contracts for electric light plants at Trinity College, Durham, N. C., Hygeia Plate Manufacturing Ice Co., Raleigh, N. C., and Salisbury Cotton Mills, Salisbury, N. C., during the past week.

The Perkins Electric Lamp Company, of 116 Bedford Street, Boston, have a neat little ivory paper cutter, which they will be glad to send to all costumers and friends.

WESTERN NOTES.

The Electric Appliance Company are exhibiting a very fine line of New England double-pole snap switches ranging from 10 to 100 amperes and with regular covers and flush caps. The flush cap switch is a recent improvement in snap switches and is intended for special work where it is desirable to have the switch set in the wall making the top of the switch flush with the surface. These are coming into use largely and the Electric Appliance Company has arranged to meet the demand by carrying them in both the New England double pole and the Acme 10 ampere single-pole switch.

Mr. W. A. Stiles, secretary and treasurer of the Van Depoele Electric Manufacturing Company, is secretary and one of the directors of the World's Fair Trust Fund Transportation Company, of 125 La Salle street, Chicago. The object of this company is to receive instalments and to issue certificates which will enable its patrons to visit the World's Fair cheaply and with the certainty of finding accommodation. The certificates are transferable and non-forfeitable, and a holder can also, if he wishes, have his money refunded at any time. The plan seems a very good one. It is a new form of the "Cook's Tourist" idea.

J. Lang & Co., 44 Michigan street, Chicago, Ill., have issued a neat catalogue of their patent steam and electrical specialties. The catalogue is arranged in the form of a folder, bound together by brass rivets. It is exceedingly handy and convenient to peruse. Their well-known main line, double-pole, throw-over and feeder switches are handsomely illustrated and concisely described. The fine line of switches for alternate currents which they manufacture are also shown up, with other various metal specialties for electrical and mechanical use.

Chas. G. Armstrong lectured before the Illinois Chapter of the American Institute of Architects, Monday evening, March 14, on the general subject of "Electricity in Architecture." In the course of his talk, which was illustrated by scores of experiments, he showed many points which, while coming properly within the sphere of the consulting electrician, ought still to be understood by the architects. The discussion of the lecture was no less attractive than the dinner preceding it, and showed how large a part the electrical fittings play in our large city buildings.

Mr. George Cutter has placed a very handsome framed lithograph picture of the Masonic Temple in his front office in a permanent state of brilliant illumination, with the legend upon it, that "Simplex conveys the juice." This is not only in the model, but in the original, through which some 65 miles of Simplex wander. This, according to Mr. Cutter, the electrical specialist of the West, is the insulation that never fails, and it produces a similar effect on the light.

Mr. H. W. Shurtz, electrical engineer of the Northwestern Electrical Engineering Co. of Portland, Oregon, passed through Chicago recently on his way East, where he was married on March 2 to Miss Josephine E. Leonard of Leonardville, N. J. Mr. and Mrs. Shurtz will return shortly to their far Western home in Oregon.

Mr. Frank H. Pond, pres't of the Pond Engineering Co. of St. Louis, was a Chicago visitor last week and received his usual hearty welcome.

The Pfister Hotel, at Milwaukee, is to have 3,000 incandescent lights, making one of the largest isolated plants in Wisconsin. The apparatus will be furnished by the Thomson-Houston Electric Co., while George Cutter is to supply the large batch of Simplex wire needed for this plant.

The Block Signal Plant which the Hall Signal Co. is to put in for the Chicago and Northwestern Railroad will require 227 miles of rubber-covered wires, and Simplex braided rubber has been selected for the purpose. This means another of Mr. Cutter's pet million-feet orders.

Mr. W. H. McKinlock, the well-known president of the Central Electric Co., is back from his recent trip to Florida, Cuba, etc., upon which he managed to combine considerable business with pleasure.

PHILADELPHIA NOTES.

The Duplex Electric Company, of Corry, Pa., have done themselves credit by installing a plant for the Erie City Iron Works, of Erie, Pa., which the *Erie Herald* says is "the largest arc light plant in Northwestern Pennsylvania. Two dynamos of forty arc lights capacity furnish electricity to sixty arc lights, that make night like joyous day. The company although furnishing dynamos for incandescent lights as well, makes a specialty of arc dynamos. In this as in the ones used to supply the incandescent lights, no rheostat or resistance coils are used, the machines being thoroughly automatic. The wiring of the giant shop was done in a superior manner, and the general construction of the whole plant has the stamp of superiority, akin to perfection."

Thomas H. Dallett & Co., manufacturers of the Billberg motors report the following recent sales: Seven motors ranging from 5 to 50 h. p. for William Sellers & Co.; one 10 h. p. motor for the Globe Cordage Works; one 10 h. p. motor for W. H. Snowden & Co.; one 6 h. p. motor for the Philadelphia Wire Works; one 1 h. p. motor for John & A. E. Lent, and one 5 h. p. motor for the Shuler House, Pottstown, Pa.

Mr. G. H. Fisher, Philadelphia manager for Chas. A. Schieren & Co., has just sold the Trenton Passenger Railway Company, of Trenton, N. J., four Electric belts, each 24 inches in width and 112 feet in length. Besides this they have just put in position for the Powelton Electric Company, of this city, a 36-inch double electric belt 132 feet in length. Mr. Fisher has a long list of smaller belts on his book of unfilled orders.

The Star Electrix Company have added a nickel-plating department to their factory, besides additional machines which will be used in turning out new specialties.

O. D. Pierce & Co. have been awarded the contract for wiring the new Hotel Venedig now under construction at 12th and Market streets.

ST. LOUIS NOTES.

The Shultz Belting Co. of St. Louis, Mo., have just sold two "Woven Leather" link belts to the Citizens' Electric Railway Co., of Decatur, Ill.; fifteen in the State of Montana; five in the State of Washington; one flat belt, 48 inches wide, heavy double, to the Municipal Electric Light and Power Co., of St. Louis, who have been using one of their 48-inch double belts for 19 months. Also one double belt to Clinton, Mass., 30 inches wide and 175 feet long, and one 36 inches wide and 210 feet long.

J. H. Siegrist, Jr., & Co., St Louis, have recently erected an "Ideal" engine of 150 h. p. in the factory of the Hamilton-Brown Shoe Co., St. Louis. This engine is used for running the dynamos of their large electric light plant.

NEW YORK NOTES.

Mr. J. W. Lattig, formerly supt. of telegraphs of the Lehigh Valley R. R. and more recently general supt. of the National Switch & Signal Co. of Easton, Pa., has accepted the position of general superintendent of the Electric Secret Service Company of New York, in special charge of their telegraph and signal department. We are told that this company has a surprise in store for the railroad and telegraph worlds.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

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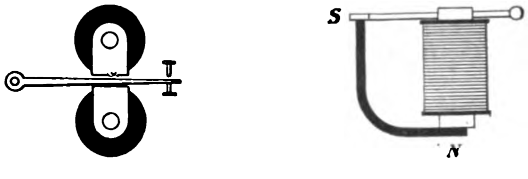
MODERN AMERICAN TELEGRAPHIC APPARATUS.—I.

BY

F. W. Jones

IN glancing over the articles in the various books lately published on telegraphy descriptive of the systems and instruments used in the transmission of telegrams, it is hard for the reader to escape the impression that no improvements in this interesting and oldest department of electricity have been made for many years, and that both attention and invention have been attracted to the more ponderous application of electricity to railroads and stationary motors and lighting. It may be true that there is not the incentive for improvements in the telegraph field as in others, for the reason that it has been occupied by but two or three companies of any importance, and when once a piece of machinery is put in general use it requires a long time to induce the executive department to have it replaced by something different; but the writer hopes to be able to show that notwithstanding this great drawback, substantial improvements in telegraphic methods and apparatus have been made during recent years. For this purpose the principal types of apparatus will be taken up in order and the changes effected on the older types pointed out.



FIGS. 1 AND 2.—SIEMENS POLARIZED RELAY.

POLARIZED RELAYS.

The first polarized relay to be generally used in the United States was the well-known Siemens relay, illustrated in Figs. 1 and 2. Mr. G. M. Phelps, Sr., made a great improvement on this relay and secured a patent therefor in May, 1878. Instead of the main line electromagnets, E M, Fig. 3, resting directly on the permanent magnet, P, they were placed so that their poles were directly opposite the armature, and yoke extensions connected them to the permanent magnet. Their figure of merit was increased and their mechanical action improved. This relay I understand is being largely superseded in the Western Union Telegraph Company by the English Post Office pattern of relay. This is practically the same principle involved in the relay used in the Wheatstone automatic system as shown in Culley's "Hand-Book of Telegraphy" (edition of 1878, page 410, plate 2, Figs. 10 and 11), and described on page 404 (also shown on page 414, plate 3, full-size figures). This relay, Fig. 4, was adopted on account of its low inductance and time constant. As stated on page 411, "The extra current of demagnetization causes considerable diminution of speed. To lessen the extra current the quantity of iron in the cores of the electromagnet is made as small as possible and the cross-connecting bar (the yoke) is suppressed so as to form a pair of bar magnets instead of a horseshoe."

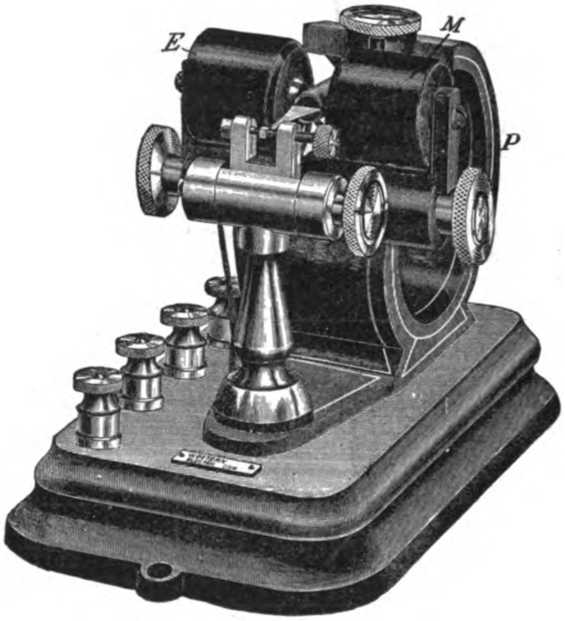


FIG. 3.—PHELPS POLARIZED RELAY.

A relay acting upon the same principle was designed by the writer as an improvement in 1884 and has had extensive use up to the present time for hand-signals, with very satisfactory results. It is shown in Figs. 5, 6 and 7. In this I have abolished the lugs or pole extensions and faced two electromagnets (each having a yoke) inwards, bringing their pole faces directly opposite the polarized soft-iron armatures. This is directly in accord with Mr. Frederick Higgins' suggestions in his paper printed in the *Journal of the Society of Telegraph Engineers*, 1877, page 122, in which he says: "Elongation of the poles beyond the bobbin and the attachment of pieces of iron to increase their surfaces exercise a retarding influence and are therefore avoided. * * * Flat armatures are used; numerous experiments having shown them to be best. Similar mag.

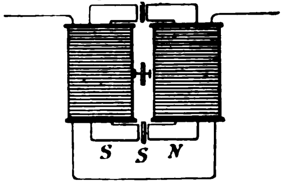


FIG. 4.—ENGLISH P. O. RELAY.

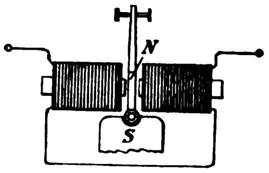
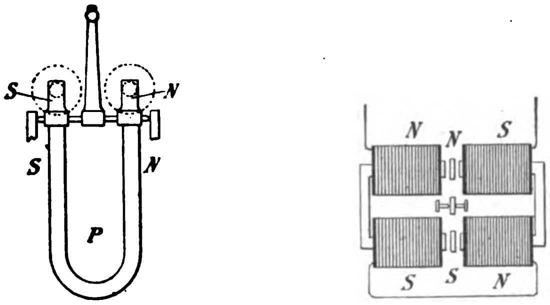


FIG. 5.—JONES POLARIZED RELAY.

netic rays cannot easily be concentrated by convergence like those of heat or light; therefore lenticular or conical faces to the magnet poles or armatures are useless, or worse."

The improvement over the English form is more electrical than mechanical. The Western Union pattern, having aluminum tongues and moving parts accurately balanced and pivoted, very greatly offsets its higher time constant. It is expected, however, that the improved relay will receive similar attention to its mechanical action and show a higher figure of merit than at present.



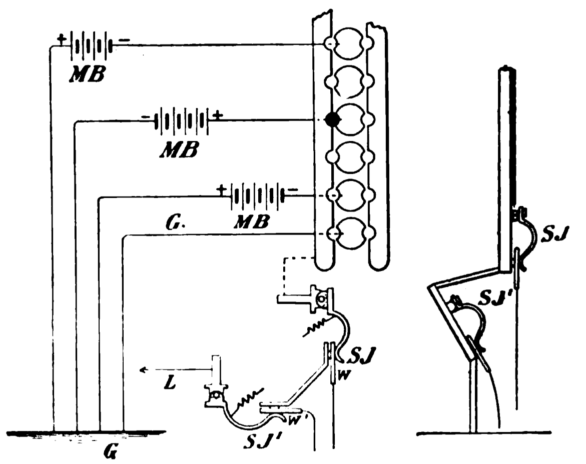
Figs. 6 and 7.—Jones Polarized Relay.

The accompanying table gives the comparative results obtained in a series of tests of the various types of instruments:

Name of relay polarized.	Resistance.	Inductance.	Time constant.	Figure of merit.	Current used.	
					Steady for inductance.	Reversals for figure merit.
	Ohms.	Henrys	Seconds.		Ampere.	Ampere.
Siemens, with lugs.	419	1.990	0.0048	700	0.0063	0.0014
Phelps, with lugs.	423	1.886	0.0045	400	0.0063	0.0025
English P. O. (W. U. style).	418	1.691	0.0041	625	0.0063	0.0016
Jones' Improved Relay.	418	1.310	0.0032	770	0.0063	0.0013

1. The inductance was measured with all the armatures, respectively, 4 mils from the poles, and the figure of merit with the armatures 32 mils distant, and the local contact point separated 8 mils.

It may be well for purposes of comparison to say that a common Morse relay of 148 ohms with its armature pressing against its poles has an inductance of 10.472 henrys and a time constant of .078 second with .0063 ampere current. With the armature 20 mils from the cores the inductance was 3.710 henrys.



S J, upper spring-jack. S J', lower spring-jack. G, earth.
M B, main batteries. L, line wire. W W' wedges and cords for instruments.

Figs. 8 and 9.—Old and New Switchboards.

SWITCHBOARDS.

Fig. 8 shows the old-style double spring-jack switchboard, which has demonstrated the superiority of the principles of its operation by a continuous use of many years. Upon this, also, there have been made very desirable changes by the Postal Telegraph Cable Company, as shown in Fig. 9.

The improvement consists in changing the position of the lower set of spring-jacks and placing them at an angle of about 45 degrees a little below and to the rear of the upper set, thus relieving the lower cords of a sharp bend which shortens their life and allowing the under jacks to have their tablets marked to correspond with their upper mates and to be always in full view of the chief operator, who can see the tags of both wedge and jack at any angle of observation whilst heretofore he had to place himself exactly in front of the upper jack, run his eye down the straps to find the lower jack and then pull out the wedge to ascertain its number. Those who have worked both systems for a long time say they would not return to the old system on any account.

INSULATED ELECTRIC CONDUCTORS.[1]—III.

BY

James Burstead Williams M.D.

Chapter III.

The replenisher and gauge are secured to the cover, R, of a large glass jar, the lower portion of which is converted into a Leyden jar by being coated inside and out with tinfoil. The replenisher is made like those in the Thomson electrometers, and is always self-exciting. Its inductors form arcs of a circle only three inches in diameter, yet, when the carriers are rapidly rotated by the fingers, a continuous brush discharge three-quarters of an inch long, in air, is produced by it. The gauge is similar to that of the Thomson portable electrometer, the adjustable attracting plate being above an attracted disc. The hair on the forked end of the gauge lever moves between the lines of the II of a small watch dial, this being the nearest substitute for the "two black spots on white porcelain" the writer could procure on the Pacific coast. The replenisher and gauge are mounted in a separate vessel so that they can be used for charging and maintaining at fixed potentials *other* bodies than the needle and jar of the electrometer. When used with the electrometer the electrode, J, of the former is connected with I, the electrode of the needle (and jar) of the latter, and the frames (and outer coatings of the jars) of the two electrically joined together and to the earth. When thus combined, the combination can be used in the same manner, and for the same purposes, as the "White pattern" quadrant electrometer.

Before entering into the details of factory work, the action of the instruments used for quickly determining the comparative insulation resistances of short pieces of insulated conductors will be described in order that future repetitions may be avoided. The instruments so used were the electrometer with its lamp, scale, shield, and lens, the discharge key, and the coil and cell operating it. The replenisher and gauge, air condenser, and battery were not used with the electrometer, etc., in this kind of testing, but were used when the insulation resistance, in megohms, of certain samples was to be determined. The use of apparatus similar to that last named is explained in text-books, and therefore need not be described herein. This last-mentioned method of testing is not suitable for quick work and, as will be seen hereafter, is not as satisfactory as the one about to be described. The electrometer is first leveled with the leveling screws—the necessary adjustments of the quadrants, etc., having previously been made—and the lamp, shield, T, and lens, L, so placed that the mirror of the electrometer, centre of the lens, hole in the shield, and edge of the flame are practically in the same vertical plane, the lamp being about two feet in front of the electrometer. (See illustration.)

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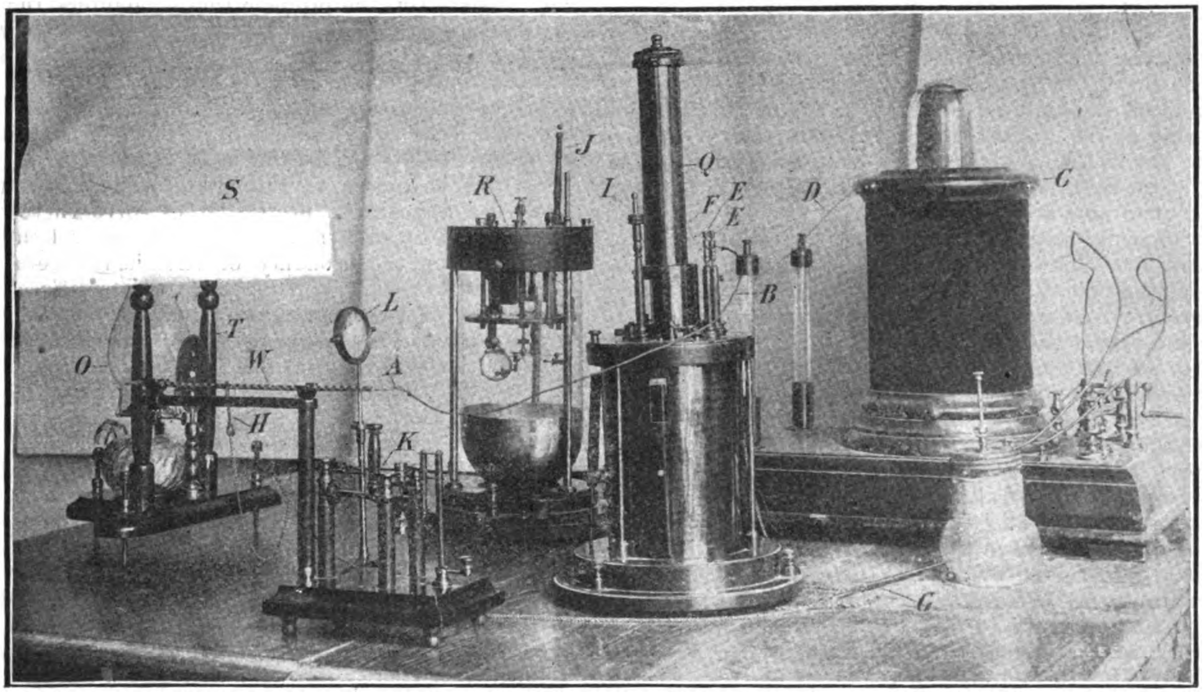
The shield and lens are next adjusted until the image of the cross-wire is well defined upon the scale, S, when the scale is placed as represented. One pair of quadrants, the needle and inner coating of the jar (that is, the acid in the jar), and the induction plate are electrically joined together and to the outer coating of the jar (and frame of the electrometer) by a fine wire fastened to their respective electrodes, and then to earth by a chain, G, or a wire, which is more reliable.

In the illustration, the electrodes of the two pairs of quadrants are represented by E and E′. The induction plate electrode is behind the tube, Q, which covers the mirror and needle suspension, and therefore not visible. F represents the fine copper wire which is fastened to I, E′, induction plate electrode, and frame of the electrometer.



Apparatus For Testing Insulation Resistance of Wires Under High Potentials.

A chain may or may not make a good "ground wire" or other connection for testing apparatus. In *all* cases its conductivity should be ascertained by the aid of a single cell and a "detector"—an electric bell would answer as well—before the chain is used, as a coating of varnish or lacquer on the metal often insulates the links from each other. The links of a bright steel chain will sometimes be so well insulated by an invisible coating of transparent lacquer that even short sparks from a coil will not pass from one end of the chain to the other. Ignorance of this fact caused the writer to make several curious mistakes, when first using the electrometer. We first test the pair of quadrants to be used, and then the discharge key for leakage. The quadrants are fully charged, by sparks, in the manner presently to be explained, to a potential previously decided upon and for which they are adjusted. The scale is then moved to the right or left (depending upon which pair of quadrants is used) until the image of the cross-wire falls upon division 300 of the scale. If the scale were several feet long and properly curved it could remain directly in front of the electrometer, as shown. The ends of the scale should always be equidistant from the centre of the mirror and its centre at the same distance from the mirror as when the spot of light was first focussed upon the scale.

If, when the quadrants are charged to a potential of 3,000 *volts and upwards*, the image of the cross-wire does not fall more than about *one division on the scale in one hour*, their insulation may be considered perfect; but if the fall be greater than this the cause of leakage must be ascertained and removed before proceeding further. The insulation of the pillar mounted on the base of the discharge key is next tested. A bare wire is laid in the U-shaped supports on the horizontal arm, the covered wire, W, and the hook, H, which hangs upon W, having been removed. The wire which has been substituted for W is now connected with one pair of quadrants, by means of a wire joined to it at A and to the electrode of the quadrants, E. The quadrants are next fully charged, as in the first instance, and, as the wire on the arm is connected with the quadrants, it has the same potential as the quadrants. If the insulation of the latter be perfect it is evident that if any leakage occurs—which is known by the spot of light passing down the scale—it must necessarily take place along the pillar. If leakage should occur the pillar must be treated until its insulation *is* perfect.

The next and last thing to be tested for leakage is that pillar of the discharge key on which the top contact—that is, the platinum-tipped screw against which the lever, K, strikes when fully released by the trigger—is fixed. This can be done by disconnecting the wire (from the quadrants) at A, and fastening it in the binding screw at the top contact. Then recharge the quadrants, as before (the lever of the key being depressed), and note whether the spot of light remains stationary after charging. It is obvious that *any* uninsulated body coming in contact with a wire connected with the charged quadrants must discharge them. Instead of disconnecting the wire at A, the hook, H, which is always connected with the top contact of the key by a flexible conductor, is hung upon the bare wire on the arm (the lever of the key being depressed) and the test conducted as above stated.

In a former paragraph it was stated that the scale was moved to the right, say, until the image of the cross wire fell upon 300 when one pair of quadrants was fully charged to the potential for which they were adjusted. But the quadrants may also be so charged that the image will fall upon 200 or any other division we please, the scale remaining in the same position as before. We will first suppose that they are to be fully charged. A wire, D, is fastened to the upper pole of the secondary wire of the coil, say, and the end brought within a short distance of a wire joined to the electrode of the quadrants. The interrupter of the primary circuit of the coil is then adjusted so that when the wheel of the interrupter is revolved by the crank any desired number of sparks is made to pass between the wires just above mentioned, at B, for instance. Whenever sparks pass at B the needle of the electrometer is violently deflected and the spot of light sweeps across and off the scale to the right. If the quadrants have been fully charged by the sparks, the spot of light immediately comes back onto the scale, passes along it to 100, say, then swings to the right again, and so on, the vibrations of the needle becoming quicker and the angular deflection of the image of the cross-wire on both sides of 300 less with each succeeding vibration of the needle until the image finally settles at 300. But if the quadrants have been overcharged by the sparks, *i. e.*, raised to a higher potential than that for which they have been adjusted, the spot of light sweeps across and off the scale to the right, as at first, but instead of stopping at 100 on the return swing it passes off the scale to the left, and after a few vibrations the needle comes to rest in its normal position. It frequently happens that the quadrants are not fully charged by the sparks at the first charging and the image comes to rest at 295, say, instead of 300. The next spark that passes at B will probably raise the potential of the quadrants too high, and they will therefore discharge themselves. Now we can either discharge and repeat the chargings until the image *does* settle at 300, or we can raise the potential of the quadrants in another way. Suppose that, after charging, the image settles at 290, and we wish to bring it up to 300. To do this we take a rod of hard rubber, electrify it by rubbing, and then touch the quadrant electrode with the end of the rod, and repeat the operation of electrifying and touching as often as is necessary.

Again, suppose that we wish to charge the quadrants to a potential represented by 250 of the scale. We charge the quadrants, as before, and the image comes to rest at 260, say. The potential of the quadrants and, of course, any *insulated* body connected with them can then be lowered by degrees by touching the electrode with a small rod of metal fastened in a highly insulating handle—any small "proof plane" would answer as well—then discharging the rod by touching it with the finger, again touching the electrode and discharging, and so on until the image is brought to 250.

We are now ready to illustrate the testing of different kinds of insulated conductors, and will commence with the cheaper grades and show what takes place when such wires are tested at a potential of about 3,000 volts.

Purchase a piece of wire, W, for instance, which is insulated with two layers of cotton saturated with paraffine, place it in the supports on the arm (see illustration) and connect it with the electrode E, as shown. Remove the hook, H, from the wire, W, and then charge the quadrants. It is evident that as long as the insulating layer of W remains in contact with the insulating supports no leakage will occur. But suppose we touch the insulating layer with one finger or any other conducting body having the same amount of surface. We do so and find that the entire charge escapes through that portion of the insulating layer immediately beneath the finger, and the spot of light passes off the scale apparently as rapidly as if the *bare* wire had been touched. We then recharge and touch the insulating layer with a body having a smaller surface then the end of one finger. The charge still escapes. We repeat the process of charging, and touching the insulating layer with a smaller body each time until we find that the charge escapes upon touching the insulating layer with the smallest practical surface, the point of a pin. If we remove the wire, W, and substitute therefor one insulated with one or two braids saturated with almost any of the insulating paints now used and subject it to the same conditions, we obtain precisely the same results.

ECONOMY IN PRIMARY BATTERIES EMPLOYED FOR GENERATING POWER.

BY

A. E. Kennelly

THERE are rules given in several electro-technical textbooks for the determination of the grouping of a given number of cells in a primary battery in order to realize from them the maximum amount of external work. This is the problem that is often presented to the telegraphist who has a number of cells ready at his disposal, and who desires to make the most of their performance under given conditions. But the problem that encounters the investor in a primary battery for the development of power, even on the smallest scale, is:—What is the criterion by which the qualifications of different cells can be judged for the purposes of generating energy? And, having selected the type of cell for a given supply of power:—What number and grouping of cells will be the most economical to employ? So far as is known to the writer, no publication has yet made its appearance professing to solve these problems directly and by rule, although much general information bearing upon the economy of chemical generators, and particularly of secondary batteries, exists diffused through the pages of periodicals and pamphlets; and, in particular, an excellent paper by Prof. F. B. Crocker on "The Possibilities and Limitations of Chemical Generators of Electricity" was read before the American Institute of Electrical Engineers in May, 1888, and in this paper the cost of galvanically developed power is clearly outlined rather from the purely chemical standpoint, than on the basis of existing batteries.

The reason for the lack of information on economical generation of power from batteries is no doubt associated with the fact that the expense of galvanic power has been almost prohibitive in the past for all purposes, and even at the present time the battery cannot possibly compete with the steam engine and dynamo for the development of large quantities of energy, considering that a kilowatt-hour must cost at least ten cents in zinc consumed alone for a battery under the most favorable conditions, while it can be produced for less than two cents' worth of coal burnt under a boiler. In spite of this disparity of cost in material however, the applications of electricity are becoming so numerous that for small supplies of power to drive fans, sewing machines, cautery knives, etc., where the inconvenience and expense of a small engine and dynamo are out of the question, a primary battery may be employed with advantage and economy, and there is at least one battery on the market that will yield a strong current when called upon to do so without appreciable polarization or local action.

This paper is therefore offered for the purpose of presenting succinctly the conditions that determine the economical selection of batteries when the power that they will be required to furnish is known. The results, like all other numerical evaluations, should be regarded as guides, rather than as oracles, since the numerous special conditions that may be contingent to each individual case may often call for a modification of the general rule.

Our first determination may be the minimum number of cells that, having each a definite E. M. F., e, and internal resistance, r, will steadily supply a current of c amperes under a uniform pressure of v volts at battery terminals. Let the total number of cells required be N, and the number of equal rows or series into which these are divided be n.

These conditions give:

$$\frac{Ne}{n} - \frac{N}{n^2} c r = v \qquad (1)$$

and thus
$$N = \frac{v n^2}{en - cr} \qquad (2)$$

It is clear that we can have an infinite number of values for N, one for each value of n which is greater than $\frac{c r}{e}$. If $c r < e$, or the drop in the cell caused by the required current is less than its E. M. F., a single row or series of cells in sufficient number can be made to supply the current, and $N = \frac{v}{e - cr}$ is a possible solution, though not, as we shall see, the most economical solution, unless it so happens that $c = \frac{e}{2r}$. If $c r$ is not less than e then evidently the current cannot be produced by any possible number of cells in one series. It will be necessary to add others in multiple.

Regarding N in equation (2) as the dependent and n as the independent variables, we obtain the minimum value of N by causing the first differential coefficient of N with respect to n to vanish while observing that the second coefficient then becomes positive. If this operation be performed, we find :

The series,
$$n = \frac{2 c r}{e} \qquad (3)$$

The number in each series,
$$\frac{N}{n} = \frac{2 v}{e} \qquad (4)$$

The total number,
$$N = 4 v c \frac{r}{e^2} \qquad (5)$$

As an example, suppose that it is required to produce 10 amperes under eight volts steadily at the terminals of a battery whose E. M. F. is two volts and internal resistance 0.2 ohm per cell.

The minimum number of cells is needed:

Here,
$$n = \frac{2 \times 10 \times 0.2}{2} = 2;$$

and,
$$N = \frac{4 \times 8 \times 10 \times 0.2}{2 \times 2} = 16;$$

so that 16 cells should be used in two parallel series of eight each. The E. M. F. and resistance of each row would be 16 volts and 1.6 ohms; so that, jointly, the battery would have 16 volts and 0.8 ohm and be capable of meeting the specified conditions, yielding eight watts externally at an efficiency of 50 per cent.

As another example, let 15 amperes be required at two volts from a battery of 1.41 volts E. M. F., and 0.3 ohm per cell.

Here,
$$N = \frac{4 \times 2 \times 15 \times 0.3}{1.41 \times 1.41} = 18$$

and
$$n = \frac{2 \times 15 \times 0.3}{2} = 4.5.$$

In this case the results are not whole numbers, and selection has to fall upon the nearest integers by trial. Thus :

Sixteen cells in four series of four give jointly 5.64 volts and 0.3 ohm, supplying 15 amperes at only 1.14 volts ; but twenty cells in five series of four give jointly 5.64 volts and 0 24 ohm, supplying 15 amperes at 2.04 volts with an efficiency of 36 per cent.

It is also evident, on inspection, that whenever formulas (3), (4) and (5) yield integral results and not fractional numbers, the fall of potential in the battery at work will be equal to the external P. D., or that the working efficiency will be 50 per cent. This is also the well-known condition that the output of the given number of cells shall be a maximum. The condition for a minimum number of cells is, in fact, coincident with the condition that those cells shall develop a maximum output, and operate at 50 per cent. efficiency.

Next, suppose that instead of requiring a definite number of volts and amperes, we are content to take the product and specify for this amount of energy without defining the pressure, with a view to ascertaining whether the range of values thus afforded affects in any way the minimum number of cells required. For instance, instead of asking for 10 volts and eight amperes in the last example, suppose 80 watts only to be in demand.

With this object in view, we readily obtain from equation (1), calling P the amount of power desired, stated in watts

$$N = 4 P \frac{r}{e^2}, \qquad (6)$$

which is the same result as that in equation (5).

n is now indefinite. This shows that the total minimum number of cells required for the development of a given power is independent of the pressure, when the supply takes place at battery terminals; and that there are twice as many independent values of n as there are pairs of factors in N; each such combination will supply the same amount of activity with the maximum output, and 50 per cent. efficiency. For instance, let 400 watts be required from cells having each 2.0 volts and 0.1 ohm.

In this case :

$$N = \frac{4 \times 400 \times 0.1}{2 \times 2} = 40.$$

There are eight ways in which the forty cells can be arranged.

1 row	of 40 cells;	E. M. F.,	80 volts;	res.,	4 ohms;	$c = 10$;	$v = 40$;	eff. = 50 %.
2 rows	of 20	“	40 “	“	7 ohms;	= 20;	20;	“
4 “	10	“	20 “	“	0 25 ohm;	= 40;	10;	“
5 “	8	“	16 “	“	0.16 ohm;	= 50;	8;	“
8 “	5	“	10 “	“	0.06254 ohm;	= 80;	5;	“
10 “	4	“	8 “	“	0.04 ohm;	= 100;	4;	“
20 “	2	“	4 “	“	0.01 ohm;	= 200;	2;	“
40 “	1	“	2 “	“	0.0025 ohm;	= 400;	1;	“

Each of these ways complies with the conditions. If, however, N is yielded by the formula in fractional form, an approximation can be resorted to with the addition of a few extra cells. If N is a prime number, then only one single series of this number of cells will fulfill the conditions exactly, but a few more added will generally allow of subdivision into parallels, if desired. All departure from the strict minimum alters of course the efficiency.

We have so far considered the number of cells only, but if p be the purchasing price of each cell, the minimum first cost of a battery that will develop P watts is

$$N p = 4 P \frac{p r}{e^2}. \qquad (7)$$

From this it follows that the electrical value of any cell (assuming the absence of polarization and local action) for purposes of generating power varies as $\frac{e^2}{r}$, for we have seen that the number of cells required is $\frac{4 p}{\frac{e^2}{r}}$. If one type of cell has 0.5 volt and 0.05 ohm while another has two volts and 0.8 ohm, their electrical values will be equal, since the same number of each must be selected in order to develop a given amount of external activity.

This rule is the same as that which governs the rating of dynamos and motors, their relative electrical value depends in every case upon the value of their $\frac{e^2}{r}$, no matter what the nature of the winding in the armature of one, or the nature of the chemicals in the solution of the other ; and $\frac{e^2}{r}$ is the power in watts that would be developed in the armature or in the cell if active on short circuit. Also the maximum output is reached in dynamos, motors, and batteries, when the external and internal activities equate, giving 50 per cent. electrical efficiency, the same rule determining in each case the minimum of plant and the maximum of output.[1] There is this difference, however, that dynamos and motors are worked at a much higher efficiency than 50 per cent. in practice, not only because it is economical to do so, but because they would become too hot if they did not, and the useful output of such machines instead of being 0.5, the condition of greatest output, varies from, say, 0.25, with 75 per cent. electrical efficiency in the smallest dynamos or motors, up to 0.02 with 98 per cent. of electrical efficiency in large multipolars. The practice with batteries has hitherto not been in the direction of such high efficiencies, and there is usually no danger of overheating them.

Again, the economical purchasing value of machines and batteries, depends so far as electrical qualifications are concerned on the value of the fraction $\frac{e^2}{pr}$ or what might be termed the short-circuit activity per dollar of cost. Two types of cell, one having an E. M. F. of 2 volts, and a resistance of 1 ohm costing $1, and the other 0.7 volt and 0.05 ohm costing $1.50, would compare in economic value for the production of power in the ratio of $\frac{4}{1}$ to $\frac{0.49}{0.075}$, or as 4 to 6.5, and the installation cost with the latter type would therefore be only 61 per cent. of that with the former for any specified activity, while independently of cost, the electrical values of the two would be in the ratio of $\frac{4}{1}$ to $\frac{0.49}{0.5}$, or 4 to 9.8. That is to say, the cell of lower E. M. F. would, by reason of its more than compensatingly lower resistance, be equivalent to nearly 2½ cells of the two-volt type.

It frequently happens that a type of cell is made in several sizes at different prices, allowing a certain range of selection as to ampere capacity. In such cases the economic first cost value, or watts on short circuit per dollar will generally vary, and that size which makes this number a maximum is the most economical to employ, other things being equal. In regard to cost of operation and maintenance, however, the ampere-hour capacity and lifetime have to be taken into separate account. Thus, in the case of two sizes of one type of cell, each having 2.0 volts, but the first with 0.9 ohm resistance costing $1, the second having 0.3 ohm and costing $1.75, the economic value of installation would compare between them in the ratio of $\frac{2 \times 2}{1 \times 0.9}$ to $\frac{2 \times 2}{1.75 \times 0.3}$, or 4.44 to 7.62; and 44 of the larger cells would represent in value 76 smaller, while independently of cost, the equivalents being $\frac{2 \times 2}{0.9}$ to $\frac{2 \times 2}{0.3}$ or 4.44 to 13.3, one large cell would replace three small ones.

Hitherto we have devoted attention to minimum first cost, but may now consider the conditions that regulate the economy in the total cost of operation. If p be, as thus far assumed, the purchasing price of one cell, then the annual interest and depreciation on this price can be estimated. Call this sum s (dollars). Also from the capacity of the cell in ampere-hours and the cost of renewal, supposed known, find the cost of an ampere-hour in labor and material. Let this sum be denoted by q (dollars). Let h be the number of hours during which the battery is supposed to work at full load during one year. Then if O be the total annual cost of operation we have

$$O = Ns + \frac{N}{n} chq. \tag{8}$$

Substituting the value of N from (2) we find

$$O = vn \left(\frac{ns + chq}{en - cr} \right). \tag{9}$$

Differentiating for a minimum it follows that

$$N = \frac{vcr}{e^2} \frac{(1+a)^2}{a} \tag{10}$$

$$n = \frac{cr}{e} (1+a) \tag{11}$$

$$\frac{N}{n} = \frac{v}{e} \frac{(1+a)}{a} \tag{12}$$

where a is the positive value of the surd quantity $\sqrt{1 + \frac{eqh}{rs}}$

Consequently,

$$O = \frac{vcrs}{e^2 a} (1+a)^2 + \frac{vchq}{ea} (1+a), \tag{13}$$

and since the total number of watt-hours supplied in the year is expected to be vch, the cost per watt-hour w is

$$w = \frac{O}{vch} = \frac{rs(1+a)^2}{e^2 ah} + \frac{q(1+a)}{ea}, \tag{14}$$

while the efficiency of delivery is $\frac{a}{1+a.}$

Equation (14) is as fundamental in the theory of economy of operation as the criterion $\frac{e^2}{pr}$ is vital in questions of first cost. It shows that when h becomes large, that is to say, when the battery is worked much and continuously, the first term in the cost diminishes in importance compared with the second, and the cost of a watt-hour tends to approach the limit $\frac{q}{e,}$ the efficiency tending at the same time to a high value. With batteries worked discontinuously and for short periods at a time, the criterion of economic value in operation tends to the fraction $\frac{e^2}{rs}$ or, what serves the same purpose in nearly every case, the $\frac{e^2}{pr}$ already found for first cost. On the other hand, for long and steady work in batteries the criterion tends to the fraction $\frac{e}{q}$ and so long as the internal resistance does not become unreasonably high, the E. M. F. of the cell per dollar of one ampere-hour's renewal becomes the leading factor. It so seldom happens in practice, however, that batteries are employed in long-continued hard work, that the latter criterion is seldom needed, but it is obvious that the more work is demanded from a battery in a given time the more economical it becomes to add to the first cost by more parallel series of cells reducing the joint resistance, and increasing the efficiency of delivery, which is in all cases measured by the ratio $\frac{vn}{Ne.}$

As an instance, suppose that eight amperes are needed during 100 hours in a year under a pressure at terminals of 16 volts from cells having 1.6 volts and 0.2 ohm each, their price $1.50, interest plus depreciation being 13⅓ per cent. per annum and the cost of renewals estimated at $0.0048 per ampere-hour per cell.

Here $v = 16$, $c = 8$, $e = 1.6$, $r = 0.2$, $q = 0.0048$, $s = 0.2$.

$$a = \sqrt{1 + \frac{2 \times 0.0048 \times 100}{0.2 \times 0.2}} = \sqrt{25} = 5.$$

$$n = \frac{8 \times 0.2}{1.6} (5+1) = 6\,; \quad \frac{N}{n} = \frac{16}{1.6} \times \frac{6}{5} = 12$$

$N = 6 \times 12 = 72$; efficiency $= \frac{5}{6} = 83\frac{1}{3}$ per cent.

E. M. F. of battery 19.2 volts; joint resistance, 0.4. ohm; drop of potential, 3.2 volts; cost of battery, $108; annual cost (interest and depreciation), 14.40; ampere-hours supplied, 800 from 12 sets, or 9,600 cell ampere-hours; cost of renewals, $46.08; total annual cost, $60.48; power, 128 watts; total work done, 12,800 watt-hours; cost per watt-hour, $0.004725.

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[1] The addition of field excitation, and the variation in the ratio of insulation thickness to diameter of conductor in different windings for an armature, introduce disturbing elements into the strict rating of a dynamo by its $\frac{e^2}{r}$. The rule is, however, sufficiently accurate for all ordinary purposes.

By formula, cost per watt-hour,

$$w = \frac{0.2 \times 0.2 \times 6 \times 6}{1.6 \times 1.6 \times 5 \times 100} + \frac{0.0048 \times 6}{1.6 \times 5} = 0.001125 + 0.0036 = 0.004725.$$

If the most economical installation, only, had been sought for, formulas (3), (4), and (5) give

$$n = \frac{2 \times 8 \times 0.2}{1.6} = 2; \quad \frac{N}{n} = \frac{2 \times 16}{1.6} = 20; \quad N = 20 \times 2 = 40.$$

E. M. F., 32 volts; resistance of battery, 2 ohms; first cost, $60; annual cost, $8.0; total ampere-hours, 800, from 20 sets, or 16,000 cell ampere-hours; cost of renewals, $76.80; total annual cost, $84.80; work done, 12,800 watt hours; cost per watt-hour, $0.006626.

Thus far we have supposed that the power to be utilized was taken at the battery terminals, or that if leads were taken from the battery to the work, the resistance of those leads was negligibly small. It becomes desirable to ascertain in what degree the conclusions already reached are affected by the introduction of sensible resistance in conductors that may intervene between battery and delivery.

Calling the resistance of the two leads together, t, equation (1) becomes:

$$\frac{N}{n} e - \frac{N}{n^2} cr - ct = v, \tag{15}$$

and the solution for this for a minimum in N gives:

$$N = 4\,c\,(v + ct)\,\frac{r}{e^2} \tag{16}$$

$$\frac{N}{n} = \frac{2\,(v + ct)}{e} \quad (17) \qquad n = \frac{2\,cr}{e} \quad (18)$$

These equations show that as regards first installation, for given values of v, c, and t, the electrical value of the cell is subject to the same criterion as in previous cases, namely, $\frac{e^2}{r}$, and since the cost of the battery will be Np, the economic first cost value of the cells is determined by the fraction $\frac{e^2}{pr}$, as before. It is evident, however, that the total number of cells required is no longer independent of the pressure, as was seen to be the case when no resistance existed in the leads, and the loss of energy in any given pair of conductors will be increased by lowering the pressure of supply. Formulas (16), (17) and (18) give, however, the minimum number of cells and thus the minimum outlay when the pressure and current are specified through leads of known resistance.

Taking, for example, the first case mentioned, of 10 amperes needed at eight volts with cells of two volts E. M. F. and 0.2 resistance, but with leads in circuit whose resistance t is 0.2 ohm, we have:

$$N = 4 \times 10\,[8 + (10 \times 0.2)] \times \frac{0.2}{2 \times 2} = 20;$$

$$n = \frac{2 \times 10 \times 0.2}{2} = 2.0$$

and 20 cells in two series of 10 each, will fill the requirements and represents the minimum outlay.

As regards economy in operation, there is no difficulty in extending the above processes to determine the number of cells and the size of conductors that shall make the total cost of operation a minimum, but the formulas become so complex that there is no practical advantage in developing them. It is evident, however, that since power from a battery is expensive, relatively, it becomes economical to employ heavy leads and by some extra first cost in conductors keep the loss in transmission as low as possible. It also becomes possible to reduce the case of economy of operation through leads, to economy of operation without leads, at least for uniform load, by adding to the power absorbed in the motor or other working device, the power that will at the full load current be lost in selected conductors, and assuming that the sum of these two is power taken at battery terminals as before.

To sum up, we have examined the conditions that regulate the economy of installation and of operation in batteries intended for a prescribed amount of work. The space that a battery will occupy, the attention that it may be expected to require, its local action, and polarization, are all factors that have to be taken into separate account for each individual case, but the following leading facts are to be recognized.

1. The electrical value of a cell for doing work is measured by its $\frac{e^2}{r}$ or, the power in watts it can expend internally when short circuited.

2. The economical value as regards first cost and installation of a cell for doing work is measured by its $\frac{e^2}{pr}$ or the power in watts on short circuit per dollar of price.

These rules hold whether there is sensible resistance in the leads or not.

3. The conditions of minimum installation and minimum first cost involve those of maximum output, with a working efficiency of 50 per cent.

4. The economic criterion of a cell as regards operating expenses depends upon the continuity or intermittence of its work. For light work it is measured by $\frac{e^2}{pr}$ or watts on short circuit per dollar of price as in the case of first cost. For heavy, sustained work the criterion becomes $\frac{e}{q}$, or the E. M. F. of a cell per dollar of renewal expense on one ampere-hour. For any given case the comparison can be effected by formula (14).

To find the minimum installation and first cost for a given power with negligible resistance in leads, formulas (3), (4), (5) and (6), may be used.

If minimum cost of operation is sought for and not minimum first cost, formulas (10), (11), (12) and (13) apply, with the addition to the power needed of the power lost in leads, if these have sensible resistance. The minimum installation for the case of leads having sensible resistance is specially dealt with in formulas (16), (17) and (18).

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—VIII.

BY

Francis B. Crocker and S. S. Wheeler.

Chapter VI.

DIRECTIONS FOR STOPPING DYNAMOS AND MOTORS.

This is accomplished by following substantially the same rules as those given for starting dynamos and motors in Chapter IV., only in the reverse order. But there are certain peculiar points to be observed in each case; so, in order to avoid any possible mistake, the matter of stopping is treated in this separate chapter. After any machine is stopped it should be thoroughly cleaned of dirt, copper dust and oil and put in perfect order for the next run. Switches, brushes, etc., should be fixed so that they will not accidentally close the circuit.

***One Constant Potential Dynamo* (*Shunt, Series or Compound Wound*)** running *alone* on a circuit with no danger of receiving current from any other dynamo or battery, should be slowed down and stopped without touching the switches, brushes, etc., in which case the E. M. F. and current decrease gradually to zero as the speed goes down. The switches may then be opened and the brushes lifted without any spark. In the case of copper bushes this should be done just before the machine stops entirely, in order to avoid any injury to them if the machine turns back a little as sometimes occurs. Never switch out or disconnect a dynamo at full or even partial load except in extreme emergency, and the brushes should never be raised while the fields are strongly magnetized as the discharge of the magnetism may break lamps or pierce the insulation.

Dynamos in Parallel.—To stop a dynamo running in parallel with one or more others or with a storage battery on the same circuit (usually constant potential) regulate down its E. M. F. until it is only slightly greater than that of the circuit (about one per cent.) and its ampere meter shows that it is producing very little current; the switch connecting it to the circuit should then be quickly opened. Under no circumstances, however, should a dynamo in parallel with others or a battery be stopped, slowed down or have its field magnetism discharged or weakened (*i. e.*, more than enough to regulate its E. M. F. as stated) until its armature is completely disconnected from the circuit, as it might be burnt out or driven as a motor if its E. M. F. fell more than a few per cent.

Compound Wound Dynamos in Parallel may be stopped by exactly reversing the method for starting (Fig. 13) but if as there suggested the "equalizer" (E, Fig. 13) is left closed all the time the machines may then be stopped like simple shunt machines in parallel, as just described.

Dynamos on the Three-Wire (Direct) System are also stopped like dynamos on any constant potential circuit as explained in the chapter on starting.

Constant Current Dynamos and Motors in series may be cut out of, or into, the circuit without trouble and may be slowed down or stopped without disconnecting them from the circuit as the current is limited. If desired, the field coils may be short circuited to stop the action of the machine while in circuit. The only precaution, and that is absolutely imperative, is to maintain the *continuity* of the circuit and never attempt to open it at any point as it would cause a dangerous arc. Hence a constant current machine must be *cut out* by first closing the main circuit around or past the machine and then entirely disconnecting it from the circuit, that is, both its wires or terminals.

One Alternator running *alone* on a circuit may be stopped or the field current shut off without trouble.

Alternators in Parallel may be disconnected from the circuit without the difficulty which is found in throwing them on, because it is not necessary to get them in phase.

A Constant Potential Motor is stopped by turning the starting box handle back to the position it had before starting (Fig. 17) or if there is a switch connecting motor to the circuit it may be opened. In the latter case a considerable spark will occur, but if it is a "quick-break" switch it may be better able to stand the spark than the starting box. The strictly best way is to turn the starting or regulating box arm back to the last contact point, which puts all the resistance in circuit, and then open the quick-break switch.

Either of these three ways is perfectly safe and the one may be adopted which trial shows to work best and burn contact points the least. A constant potential motor like the corresponding dynamos when in parallel, should never be stopped or much reduced in speed or have its field discharged or weakened until it is disconnected from the circuit, otherwise its counter E. M. F. is not enough to prevent an excessive current from rushing through its armature.

Thus it will be seen that the constant potential machine is exactly the opposite of the constant current. The former is safest when the circuit is open and it is very bad to short circuit or stop it with the current on, whereas the latter is safest when the circuit is closed, and the machine may be stopped or short circuited while in circuit. In the latter case a dynamo would require an effective regulator.

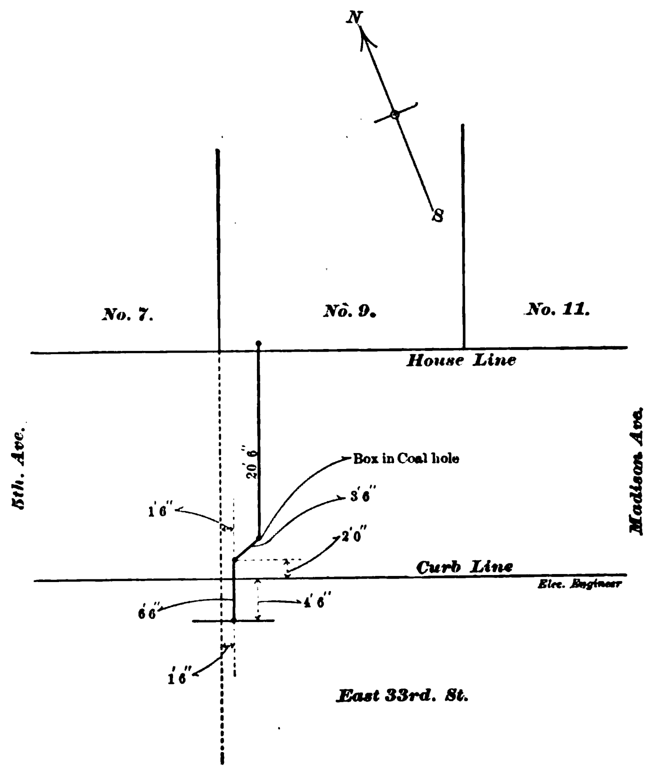
PUTTING IN A HOUSE SERVICE FROM THE EDISON THREE-WIRE SYSTEM.

BY

H. Frank Korthener.

The three-wire system of underground tubing and boxes used by the Edison Electric Illuminating Company, of New York, is familiar to all, but the work of putting in a service or stub from the main, laying a new line, or repairing a "burn-out," may not be so generally known.

This work is done by one of the gangs of men in the employ of the company. A gang consists of a foreman, tester, jointer and a number of laborers. Before the work can be commenced, a permit must be obtained to tear up the street; a "location" is also sent from the office. This location is a map of the street in front of the house in which the service is to be put, and shows the position of the line and nearest boxes.



Putting in Edison 3-Wire House Service.

The service is laid from the nearest box; if this box is near enough to the cellar of the house a tunnel is dug to it from the cellar; if it is not, a trench must be dug in the street and across the pavement. When this is done, the necessary measurements are taken in the trench for the length and direction of the tubing required, and some of the men are sent to the company's yard to get the pieces wanted.

Then the jointer takes off the "box" on the main line, and cracks off the hard compound filling it, which encloses the copper wires, or "coppers" as they are called. The compound left sticking to the coppers is melted off, and they are then wiped and cleaned.

After the tubing has been brought and laid in the trench, it is tested, before being joined up. The testing arrangement consists of a portable astatic galvanometer, a 50-cell chloride of silver battery and a set of leads. The leads are made of two conductors of flexible lamp cord, drawn into a piece of soft-rubber tubing about six yards long. The galvanometer and battery are set up on the sidewalk, and the leads reach in the trench to the pieces to be tested. The battery and galvanometer are connected in series and if there is no deflection of the needle of the galvanometer when the leads are put on the tubing, the piece is "O. K."

In testing the pieces, one of the leads is put on the iron tube, and the other on each of the three coppers in succession. Then the leads are put on the first and second coppers, first and third, and second and third coppers. Then the needle is allowed to swing off by holding the bare ends of the leads in the hands, to show if everything was in working order when the test was made.

After the pieces have been tested they are joined together with flexible wire joints and the boxes are bolted on. Then the last joint, on the main, is made; this is generally a "live" joint and some caution must be observed in soldering, not to have the solder short-circuit the coppers. The jointer must be still more careful in some cases, where, in order to get at the box, he must crawl his whole length in a tunnel barely large enough to admit his body.

When all the boxes are on they are filled with hot compound and closed up. The compound, when it cools, hardens like pitch and forms an excellent waterproof insulator. Before the boxes are covered over with earth they are located by the tester in the manner shown in the accompanying sketch. A box is generally located in two ways; first, by the perpendicular distance in, or out, from the line of the curb; and, secondly, by the perpendicular distance from the nearest house line between two houses, the house line being supposed to continue into the street. A drawing of the location and notes upon it, are entered in the tester's "field-book." Slips are made out by the tester giving the district, street, side of street, house number, length of service, size of tubing, date, foreman's name and tester's name. This slip also contains a drawing of the location and is sent to the office when the permit is returned.

When the boxes have been located the trench is filled up and the pavement and sidewalk replaced. The work is now finished and it is only necessary to connect the house wires and meter to the service for the consumer to obtain light or power.

TELEPHONIC PROGRESS IN AUSTRIA.

THE telephone in Austria, according to the London *Electrical Engineer*, continues to make steady progress. The subscribers in Prag, Trieste, Lemberg, Graz, Czernowitz, Pilsen, Reichenberg, and Bielitz, have increased to 3,624, and in Vienna to 5,200, and in the 47 small exchanges opened by the Government since 1889 to 1,716, a total of 10,540. In Vienna the majority of the lines are underground loop lines; reckoning these as single, there are now 12,250 miles laid, and 9,500 being laid. The total telephonic wire mileage for the country amounts to 25,800. The cables used in Vienna are 1 mm. copper wire, covered with 1 mm. gutta-percha. There is only one exchange in Vienna into which now 5,000 looped lines run, and about 3,000 more are being run into it to provide for future extensions. The most distant subscriber is some four miles from the exchange. Interurban trunk lines have also been pushed forward; there are now 23, of which the most important are: Vienna-Prag (direct), 191 miles; Vienna-Prag (*via* Brünn), 219 miles; Vienna-Brünn (direct), 79 miles; Vienna-Budapest (three lines), 250 miles; Prag-Tilschen, 72½ miles; Prag-Reichenberg, 70 miles. The Vienna-Trieste line will be commenced in March *via* Graz; it will be 313 miles long.

ECONOMY IN ARC LIGHT WIRING.

BY

H. B. Rommel

I HAVE noted with interest the suggestions made by Mr. Sharpsteen on arc light wiring in THE ELECTRICAL ENGINEER of March 16, and fully appreciate the necessity of economy in this direction. From time to time we hear of many plans for reducing the amount of copper on our incandescent circuits, but the question of reduction on arc circuits seems to have been sadly neglected by our electrical engineers. While economy in the former instance is no doubt the most desirable, we still find a large field for improvement in the latter, which means less capital to the investor and a corresponding reduction in the amount of line repairs.

The plan used by Mr. Sharpsteen would be of value in but very few instances as, in order to effect any saving in wire, both municipal and commercial lights must be located on, or very near, the same street. In the majority of cases, however, it is found necessary to string one line through one street and return by another. This would necessarily cause a constant return of the line to either street in order to keep the commercials in rotation, and would consume more wire, and require more poles, in many instances, than by running an entirely separate circuit.

The objection to wasting power, caused by starting municipal lights at the same time as commercials, raised by Mr. Sharpsteen, is to the majority of electric light superintendents the least consideration, as on nearly all circuits single-carbon lamps are used for commercial lighting, and in many cases the consumer neglects to turn out his lamp when business hours are over and at the time contracted for. The lamp then, on burning to the full length of the carbon, cuts itself out automatically, but still has the full current traveling through its magnet coils; and this is not only detrimental to the adjustment of the lamp, but to the life of the coils themselves. Here we have another and greater loss of power caused by the lamp burning from the contract time to the point of cut-out, as well as materially injuring the mechanism; and in order to obviate these difficulties it is absolutely necessary to control our commercial lamps from the station. I have made it a point, of recent years, to place a short-circuiting switch in addition to the ordinary cut-out within easy reach, and the result has been more than encouraging; the switches saving over and over again their original cost in power and life of lamp.

To my mind the advancement of economy in arc wiring lies more in the direction of a single circuit from which all commercial and municipal lamps can be turned off and on by an automatic cut-out operated by battery from the station. This automatic cut-out will take the place of the ordinary cut-out, and the amount of wire necessary to operate them will be a comparatively small item. We find just such an automatic switch employed for incandescent work, and illustrated in the same issue of THE ELECTRICAL ENGINEER; and it is but a question of a short time when this plan will be adopted for arc circuits, thus materially reducing the consumption of copper by local electric light companies.

SERMONS BY TELEPHONE.

THE TELEPHONE COMPANY of Glasgow has completely fitted up an elaborate telephonic arrangement in Woodside Church, whereby the subscribers are enabled to hear the entire service at home with the utmost distinctness and ease.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed*, EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XIII. NEW YORK, MARCH 30, 1892. No. 204.

Truisms which one has verified for one's self out of a personal experience, are apt to have a special value to the owner.—Prof. S. P. Langley.

OIL AS AN INSULATOR.

IT may be laid down as an established fact that the creation of a new art is accompanied almost invariably by developments in collateral lines and the employment of methods and apparatus in a practical way that had up to that time been used merely experimentally. The recent enormous impetus given to high tension transmission is no exception to this rule, and those who have followed the course of recent events must be thoroughly impressed with the important position assumed by oil as a means of insulation. The results obtained in the Lauffen-Frankfort transmission have already given indication of the value of oil as an insulator for overhead lines and in that respect had only tended to confirm the results already obtained with it on circuits of comparatively low potential difference. Mr. Tesla and Prof. Elihu Thomson had also demonstrated its value as an insulating medium for high tension currents, and, in general, for the insulation between primary and secondary coils of converters. As regards the history of oil as an insulator we note that in an excellent paper read before the Institution of Electrical Engineers, Prof. D. E. Hughes, lays claim to having first employed it in this manner, and in substantiation thereof cites the patent issued to him on Jan. 11, 1859. But it is the results obtained by Prof. Hughes which he gives in his lecture to which we would rather draw attention, and which prove unquestionably the great superiority of oil over even the best of solid insulators heretofore employed, not excluding gutta-percha. Prof. Hughes shows in effect that the value of oil as an insulation increases both with the potential of the charge and also with the rapidity of alternation; for when the experiments are made by an impulsive rush so as to have the greatest number of vibrations per second, in the neighborhood of one million, even the poorest oil, such as castor oil, shows marked superiority over air or gutta-percha, a behavior which recent investigations have shown to be in direct contrast to that of solid insulation material. Prof. Hughes also showed that a spark from a Leyden jar which would usually pierce four inches of air would not pierce one-nineteenth of an inch of rosin oil, proving that oil when resisting an impulsive rush has seventy-nine times higher insulating powers than air.

But there is another application of oil insulation, pointed out by Prof. Hughes, which ought to receive the most serious consideration by manufacturers of submarine and underground wires, and that is, the remarkable power of self-restoration when the insulation is temporarily destroyed by a puncture or cut so as to lay the wires bare for an instant. As an example of this, Prof. Hughes showed a thinly coated gutta-percha wire plunged into a small lead tube containing rosin oil. A cut through the gutta-percha, laying bare the wire, destroyed the insulation for an instant, but in less than a second the oil percolated through the cut and restored the insulation to its previous high value. The prescience of Mr. David Brooks and his steadfast advocacy of oil insulation, entitle him to be recognized as a pioneer in this field. In this connection the insulators described by Mr. Hewett in another column would appear to fulfil the conditions suggested by Prof. Hughes in constantly providing a fresh insulation for underground bare conductors.

But there is one aspect of the question of oil as an insulator which must not be lost sight of, if we apply this method to telegraphic, and more specially to telephonic and to high tension work. We refer to the high specific inductive capacity of the oils in general, that of rosin oil being equal to, if not greater, than that of gutta-percha. The effect of this increase in capacity in telephone cables must necessarily shorten the effective talking distance to a very large extent; indeed, so narrow is the margin here permissible that dry-paper insulation may now be said to have become the standard of American practice, and involving a capacity of .075 microfarad per mile, as against .30 for gutta-percha. The effective capacity of the line in high tension alternating work was only too well shown in the Lauffen-Frankfort transmission, where a large part of the power was absorbed in charging the line alone. It may be argued that this charge is one which is constantly restored, and hence entails no expenditure of power, but it would still entail an increased capacity in the generating apparatus for a given power to be delivered at the other end of the line. It is not, improbable, however, that difficulties in this direction may, in the future, be overcome by counteracting devices involving auxiliary condensers and coils with high self-induction. There can be no reasonable doubt that while the solid insulators still have a large field of usefulness before them the liquid insulators will occupy a prominent position in the future in high tension electrical work. Before the employment of oil becomes general, much will have to be done in studying its actions, especially when used in connection with fibrous and other insulating materials. In the excellent series of articles by Dr. J. B. Williams, now appearing in our columns, special reference will be made to this important and timely subject.

THE ADVANTAGES OF A BUGABOO.

Twice within a few weeks we have been appealed to by readers to make some effort by way of stopping the spread of the reckless habit into which newspaper reporters, and some insurance people, have fallen of ascribing every mysterious fire to electric wires. One recent instance occurred in New England, and another happened at the destruction of the Smith-Gray building in Brooklyn, when the fire was attributed to electricity, although the owner, who ought to know something about the matter, said that the idea was perfectly absurd. In our current issue appears a letter from St. Louis protesting against the reports of the fire in the Liggett & Myers building, on the very reasonable ground that there was not a wire within 40 feet of the place where the fire broke out.

So far as the newspaper men are concerned, we can only advise our friends to have patience. Newspapers are generally open to the argument of facts, and in due course they will learn that while electricity has its dangers, it is the *safest risk*. Insurance companies know this, but in the gradual introduction of electricity they see the opportunity to advance, piecemeal, their present low rates of insurance, so that by the time all good buildings have electricity, everybody will be paying higher rates. There may be no defined plan about this, but there is beyond question a tendency of the kind suggested. Our insurance contemporary, *The Standard*, of March 19, in a leading editorial says: "Electricity is recognized as a bad hazard, but with approved lighting installation *is placed ahead of kerosene or gas*." Here again, however, the drift of policy we have referred to is shown for it is added: "A charge is very properly made where the electric trolley wire is used for street car service." Now last week, we pointed out that 87 per cent. of the cities over 200,000 inhabitants, in this country, and 97½ per cent. of the cities between 50,000 and 200,000, have trolley roads. Are we to infer that in every one of these a building whether it has outside connections or not, is "properly" liable to an extra charge? If so, anybody can see at once that an enormous percentage of insurance comes at once under heavier assessment, although it has a form of lighting that "*is placed ahead of kerosene or gas*." We may note that the addition on account of trolley systems is 2 cents. We also note that, in spite of the statement or admission in *The Standard*, the new schedule submitted by the underwriters to the companies assumes that the "standard building" is lighted by gas, and provides that even where the electrical installation is approved, 1 cent shall be added for electric lighting. In other words, electricity is a convenient bugaboo for squeezing an extra 3 cents out of insurers. We agree with our correspondents that it is time a kick was made.

THE COST OF CURRENT FROM BATTERIES.

In spite of the almost universal employment of the dynamo as a current generator, the galvanic battery still has a large field of usefulness which it is likely to enjoy for some time to come. To discuss its economic value, therefore, is opportune, and the discussion is valuable when taken up on the lines adopted by Mr. A. E. Kennelly on another page. The author shows in general the marked influence of the internal resistance on the working economy of a galvanic battery, not only from the electrical standpoint, but also when considered as a factor in relation to the cost of cells to obtain a given power, so that under certain conditions a high voltage cell may be less economical than one of lower voltage having low internal resistance. Mr. Kennelly points out, in addition, the various conditions governing minimum first cost of installation and minimum cost of operation, a relation which has probably never been clearly pointed out in connection with primary batteries.

FENDERS FOR ELECTRIC CARS.

It is interesting to note in the annual report of the Massachusetts Railroad Commissioners the statement that no fender has yet been found which is efficient for the saving of life. Some fenders have been tried since the introduction of electric cars, but the results are not satisfactory; on the contrary, the fenders appear to have been in more than one instance an additional peril to the person who has had the misfortune to get under an advancing car. It would seem that the invention of a satisfactory fender ought not to be difficult, but the fact that cable cars are still without them indicates that the invention has not been made. Cable cars are much more dangerous than electric if only for the reason that their direction of travel cannot be reversed. The probability is that as people become accustomed to the swifter motion of mechanical cars, they will cease to gauge them by the slower standards of animal cars, and then there will be fewer accidents. But of course the greatest safety can only be attained by having the tracks above or below the surface of the street.

HIGH FREQUENCY DISCHARGES.

The extraordinary enhancement of high tension discharges when accompanied by high frequency of alternation is shown in a most marked degree by the experiments described in another column by Prof. Elihu Thomson. These very interesting experiments also show in a striking manner the influence of the number of primary turns on the rate of oscillation, so that a given condenser requires a primary in unison with it to obtain the maximum effect. The importance of large, smooth surfaces to resist puncture in oil and air with such potentials is also pointed out.

ECONOMY IN ARC LIGHT WIRING.

The communications which appear in our columns this week would seem to show that arc lighting practice is still far from that condition which incandescent work has attained where economy in wire is concerned. The methods for securing a saving of circuit as shown in our March 16 issue by Mr. Sharpsteen and in to-day's by Messrs. Young and Mackie are based on different principles and are well calculated to constitute a good basis of comparison for arc light station managers. A suggestive discussion of the subject is also furnished by Mr. Rommel, a practical central station manager. Now that prices for street lights are cut down so near the point of unprofitableness, these methods of economizing in circuit construction, or in operating expense, become more and more worthy of attention.

ECONOMY IN ARC LIGHT WIRING IN NEW YORK CITY.

BY

C. J. Young.

The article by Mr. S. H. Sharpsteen in The Electrical Engineer of March 16, 1892, will no doubt be favorably received by the superintendents of arc light plants, and while there has been but little said of the economy in wiring, as practiced in such plants, still there has been advancement made in the saving of wire and circuits in some of the recent arc light plants installed, and for the benefit of the large majority of central stations it is hoped that others will contribute information, and bring up the standard of economy in arc light wiring to a favorable comparison with the best practices known, for the distribution of power and incandescent lighting on the constant potential systems.

It would be interesting to determine the exact saving as shown in the scheme proposed by Mr. Sharpsteen; for if there happened to be more commercial than city lamps on the 3-legged circuit, the extra cost of the third leg might be more than the saving of coal effected by starting the city lights later than the commercial. However, the idea of the third leg is of value and can be used to great advantage in many cases.

There are many disadvantages in running the dynamos in series, and therefore, where a circuit has as many as 100 arc lamps connected and the dynamos are of 50 lights capacity, a third leg connecting the middle point in the circuit and running back to the station and used as a common return wire for the two 50-light dynamos, allows city lights to be connected on one positive leg, and the commercial lights to be connected on the other positive leg, and they can therefore be started and stopped independently of each other; or all lamps to be operated until midnight may be connected on one positive leg, and the "all-night" lights connected on the other positive leg, and thus two arc circuits can be operated independently of each other and with but three wires.

I may instance a case where this idea was put to good use in New York City, where a company is operating two stations, one down-town and the other up-town, the two stations being connected by a trunk line which operates some of the up-town station circuits from the down-town station, and also commercial lights between the two stations. The remaining circuits were operated from the up-town station. On account of the pressure of business the writer designed the scheme shown in Fig. 1, which allowed of the operation of three dynamos on two circuits, each dynamo being independent, and entailed no increase in voltage, as would have been the case were the dynamos connected in series.

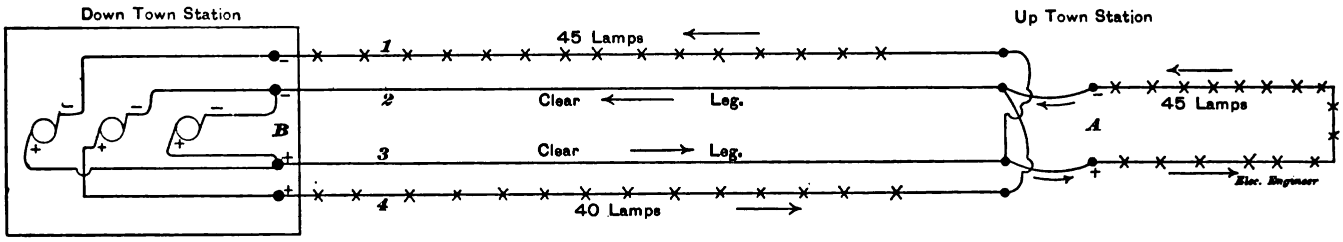

FIG. 1.

This arrangement allowed of the saving of two wires between station B and station A, a distance of six miles, *i. e.*, 12 miles of wire. Of course, it will be readily understood that the legs 2 and 3 carry twice the current of legs 1 and 4, being required to take the current of lamps emanating from station A, in addition to the current for the lamps in legs 1 and 4. The actual current in 2 and 3 was 20 amperes, the normal current being 10 amperes. The wire was No. 6 B. & S., and proved quite ample for this purpose.

Another case where the 3-legged circuit was adopted, was for the operation of (1) a continuous day and night circuit, (2) a day circuit only, and (3) a city night circuit, all three services carried out with the use of but three wires. As shown in Fig. 2, all of the day service was connected in the leg marked r, all the continuous service customers requiring current 24 hours daily connected in leg marked A, and city lights and night service customers connected in leg marked C, one dynamo only being employed. During the day the dynamo was connected with A and B, and at 6 P. M., the dynamo cable was transferred from B to C, and again in the morning replaced in B. For the safety and protection of the day trimmers, a switch was placed at S, which was required to be disconnected in the morning before trimming, and again thrown on after all lamps were trimmed. In this case the amount of wire saved is equivalent to three conductors equal in length to the distance between B and S. This system of circuits, though now discontinued, was found flexible and economical, and if well managed is simple and safe.

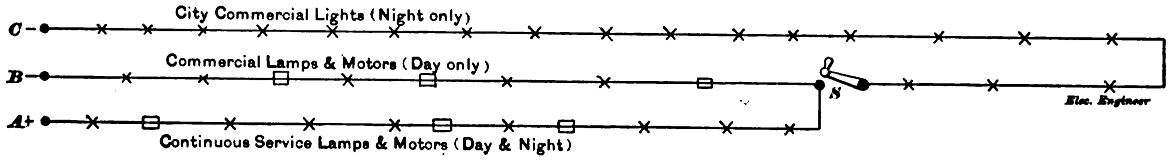
City Commercial Lights (Night only)
C−
Commercial Lamps & Motors (Day only)
B−
A+
Continuous Service Lamps & Motors (Day & Night)
S
Elec. Engineer

FIG. 2.

TESLA APPARATUS.

A Tesla experimental apparatus is being constructed for lecture purposes at the Finsbury Technical College, says the London *Electrical Engineer*. The students will be very much on the *qui vive* the first time Dr. Thompson ventures to take the million-volt shock into his body. Some one must evidently follow suit to Mr. Tesla, but we have heard the opinion expressed by several engineers that they would hardly like to build and test such an apparatus with a trust in its harmlessness merely from abstract or mathematical reasoning without trying it, say, on a calf first. Mr. Tesla has a splendidly-equipped laboratory in New York, and the experiments he showed at the Royal Institution are by no means all he had to produce, given more accurately determined conditions.

MUNICIPAL LIGHTING IN CHICAGO AND ELSEWHERE.

BY

M. J. Francisco

My attention has been called to a paper by M. H. Mikkelsen on "Electric Street Lighting in Chicago," which is being widely circulated by the advocates of municipal ownership. The author is evidently a votary of municipal ownership and cites Chicago as a shining example of remarkable success financially, and especially calls attention to the fact that the city is "free from the influence of Federal politics."

It is a peculiar coincidence that this laudation of Chicago's aldermen should be followed by Associated Press reports that are being flashed over the country, announcing that "ten of these very honest and reliable aldermen are boodlers and have received $560,000 as bribes in the closets of the City Hall," and that they have adopted the famous Tweed Ring tactics and emigrated. This is a conclusive and practical illustration of the position that I have heretofore taken that municipal lighting should not be owned by a city and controlled by a ring for political or other purposes.

In this paper the author plainly states that electric lights in Chicago cost less than in other cities, because the city owns the plant. It is evident that the author has had no practical experience in electric lighting, and bases his suppositions on theories instead of facts, and it is only charitable to suppose that he has been misinformed, as the figures he quotes regarding the cost of lights in various cities are so utterly at variance with the true condition of the business in those cities. The author claims that the total cost of organization and maintenance of Chicago's electric lighting system is $556,000.

The comptroller of the city, in his financial report, states under oath that the plants cost to January 1st, 1891, $526,184.47; this would leave only $29,815.53 as the expense of running the lights for over four years, according to this author's statement; while the comptroller states that he paid $132,804.48 for expenses of lights for one year. To this must be added the expenses of lights for three years previous to 1891, and we find that the statement regarding the cost made by the author of "Electric Street Lighting in Chicago" is over a quarter of a million dollars less than the actual amount paid by the city.

With over a quarter of a million left out of the account it is very easy to make the cost of lights $68 per year. What are the facts? The pay-roll of the electric lighting department of Chicago, November 7th, 1891, was as follows:

4	Chief Engineers	at	$1,200	$4,800
6	Assistant Engineers	"	1,000	6,000
8	Oilers	"	720	5,760
11	Dynamo Tenders	"	900	9,900
4	Chief Trimmers	"	900	3,600
17	Trimmers	"	720	12,240
16	Firemen	"	720	11,520
4	Day Men (at plant)	"	720	2,880
2	Linemen	"	900	1,800
3	Trouble Men	"	720	2,160
1	Time Keeper	about	1,000	1,000
2	Bookkeepers	"	1,000	2,000
1	Electrician	"	3,000	3,000
2	Assistant Electricians		1,500	3,000
				$69,660

(The above pay-roll does not include the names or pay of thirty employees discharged immediately after the elections of November 3d, none of whom received less than $720 per year.)

The total number of lamps in operation at that date was 963. Therefore, with 963 lamps and a pay-roll of $69,660 per year, we have an outlay of $72.33 per lamp for labor alone, not including anything for coal, oil, waste, interest, repairs, depreciation, water rent, taxes, broken globes and lamps, carbons and other contingencies. Add these, and we find the cost is nearly $190 per year per lamp. With the business in this condition, will the author kindly explain if it was by the system of mathematics taught at the institution he represents that he made the cost of lights only $68 per year?

Notwithstanding the statement that it only costs the city $68 per year to furnish the lights, they have just closed a seven years' contract with one of the local electric light companies to furnish 280 arc lights for street use at $182.50 per year.[1] Would the city pay a private corporation $182.50 per year per lamp if they could produce the light themselves for $68? The author of this paper will find that actual practice and the facts developed by daily business furnish a more reliable basis to work upon than theory and imagination.

The assertion is made that Boston pays $237.25 per year for each lamp, because their lights are furnished by a private corporation. The price paid in Boston is forty cents per night, each lamp burning 365 nights per year, being $146, and $36.50 per year less than Chicago has agreed to pay for the same lights, with coal in Chicago at $1.33 per ton, and in Boston $4.50, and the former city owning a plant of its own. Comment is unnecessary.

The municipal plant at St. Louis was quoted in the hearing before the Massachusetts Legislature as an example, showing that other electric light companies were robbing the public. The St. Louis company have decided to throw up their contract and forfeit their bonds of $50,000 rather than continue the lights at the price called for under the contract. Here is one of the largest and best plants in the United States, favorably located where fuel is cheap, trying to produce street lights for $75 per year. After a year's trial, with the best of management and scientifically handled, they are willing to forfeit $50,000 rather than continue the business at that price.

Do the advocates of municipal ownership imagine that misleading and incorrect statements will benefit their cause or advance their interests? Why not give the facts fairly as they exist and show a true comparison of the two plans, giving all the expenses in each case, and not garble reports? Then the public and taxpayers can judge for themselves which plan is most desirable.

THE SOUTHERN ELECTRIC COMPANY'S SYSTEM OF CONTROLLING LIGHTS.

We have already described in our issues of March 9th and 16th some of the features of the new system for controlling incandescent lights, which has just been brought out by the Southern Electric Company, of Baltimore, Md.

In our March 16th number we showed the "P. & M." push-button switch, and illustrated how, in a very small space, any number of lights may be controlled—turned on or off—by the use of push buttons instead of a switch controlling the current passing through the lamp itself. We illustrate this week a special form of socket, which is perhaps the most important feature of this new system—a socket which is being made for all standard classes of service.

Fig. 1 shows the socket switch itself. This is an electromagnetic key operated by an ordinary battery circuit, controlled by the simple and ingenious push-button switch already described. Fig. 2 shows this switch mounted upon the socket, while Fig. 3 gives an interior view of the combination.

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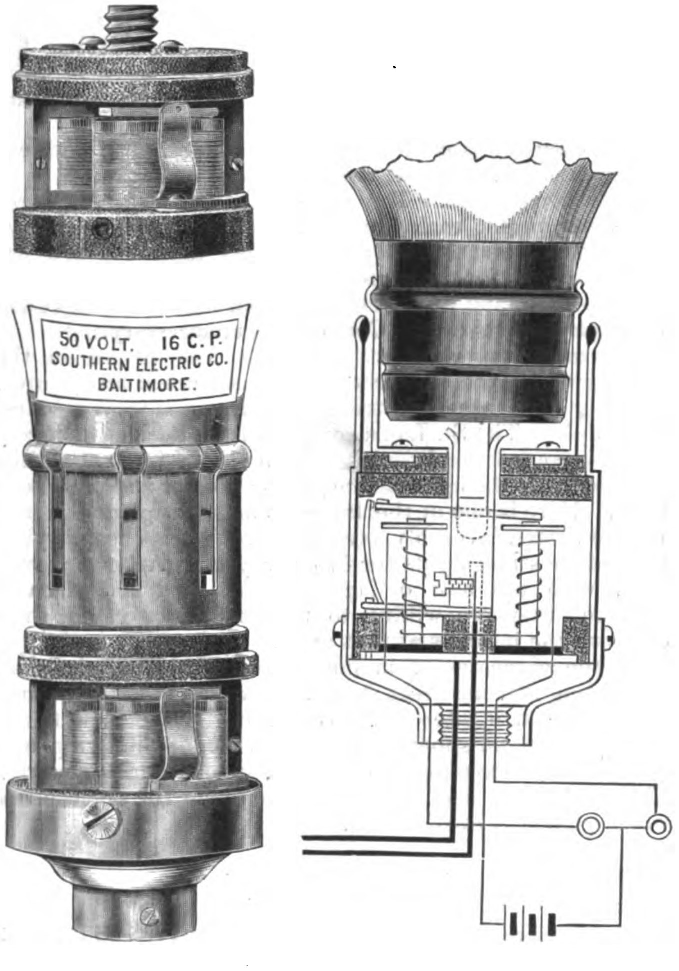
[1] Mr. C. H. Wilmerding, general manager of the Chicago Arc Light and Power Co., in a letter to the Editor of The Electrical Engineer, of March 25, says: "In regard to the statement that this company had secured a contract for seven years' city lighting at $182.50 per lamp, would say that although an ordinance to that effect passed the council, it was vetoed by the Mayor."

It will be readily seen that any lamp or any number of separate lamps may be controlled from many different points without changing the lamp circuit itself. If, for instance, in a dwelling it is desired to turn on or off a lamp in any particular room, the push button controlling the special form of socket shown above, may be as many and as far from one another as necessary, the extension of the number simply involving further continuance of the battery circuit which controls the electromagnetic key of the socket.



FIGS. 1, 2 AND 3.—THE P. & M. PUSH BUTTON SWITCH.

Now, if this principle is a good one in the case of a single lamp, why not use it in the shape of a switch controlling a group of lamps in an electrolier? This idea has been carried out in a fixture switch, the operation of which is essentially the same as that of a single lamp.

The system above briefly described is obviously applicable with great economy to the work of theatres, club houses, business houses, residences, and in fact, everywhere; it also possesses advantage in its adaptability to any existing system of incandescent lighting, dispensing with heavy switchboards, snap switches, rheostats, etc.; it has already been introduced in a number of club houses and residences with great success.

The contrast between this system and the old method of operating lights is conspicuous in the case of a well-known installation in Baltimore, where a small board less than 12 x 7 inches, with simple push buttons absolutely controls 140 lights which can be turned on or off by groups or all together, by a light pressure of the finger. It would, therefore, seem that the novelty, economy and pliability of the system generally, cannot fail to interest those actively engaged in electrical construction work and exert a marked effect upon future installations.

DYNAMIC INDUCTION AT HIGH POTENTIALS AND FREQUENCIES.

BY

Elihu Thomson

IT is the purpose of the present writing to supplement the experiments which were described by me a short time since, in which condenser discharges at comparatively high potentials were used to induce by dynamic induction similar discharges in parallel circuits or coils. The application of the principle to the production of an efficient lightning protector or device affording a selective path for high frequency discharges has already been pointed out. So also the effects of the use of varying numbers of turns in the

Fig. 1.

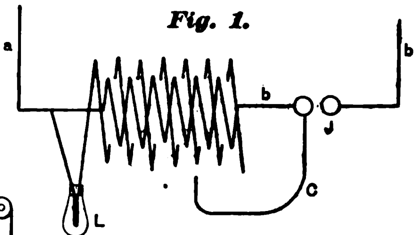


Fig. 2.

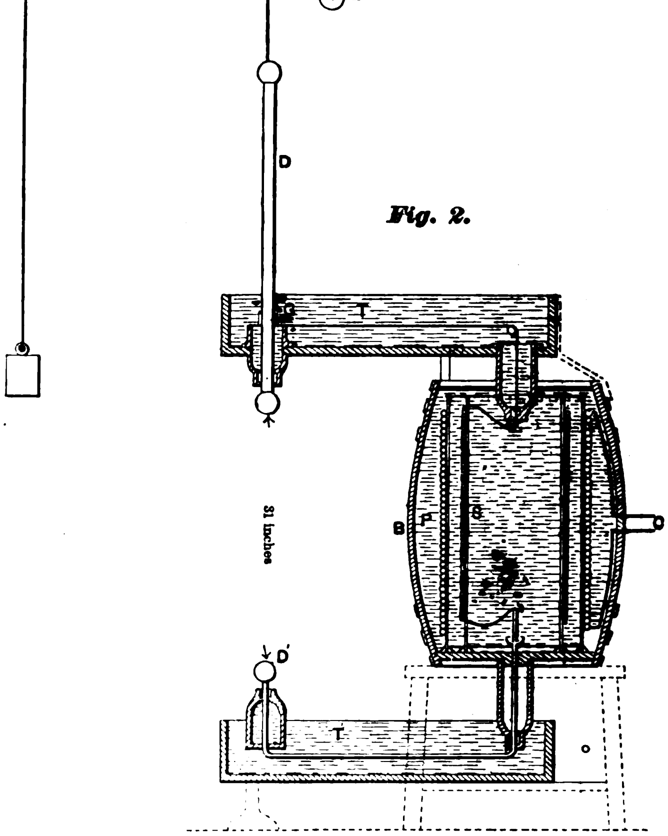
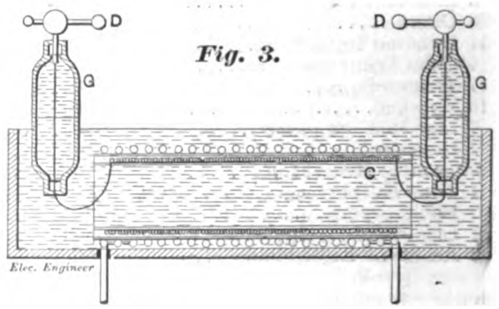


Fig. 3.



coils under induction have been shown; effects which have enabled me up to the present to obtain sparks of over 31 inches in length in free air between ball terminals about one inch in diameter and in an apparently continuous stream of not less than 250 per second. These sparks are bluish white, like Leyden jar discharges, and are accompanied by a loud rattle or roar. These effects and their bearing on insulation will be further adverted to.

The following experiment is an exceedingly instructive one, as showing the means I use for obtaining a balance of E. M. F.'s or selective path : Two coils of heavy wire are wound, each having about 12 to 15 turns, more or less. The coils are separated by a glass cylinder, one coil being in the interior of the cylinder and the other being wound outside thereof. Connections are made as in Fig. 1. The turns of the coils should be kept apart, or well insulated from one another. An incandescent lamp L is put in circuit with one of the coils, as the outer one, by putting one terminal of the lamp in connection with one end of the inner coil and the other lamp terminal to one end of the outer coil. The wires *a b* permit condenser discharges to be passed through the inner coil; a branch wire C is taken from *b* and its free end can be connected to any part of the outer coil so as to include more or less of the turns of the outer coil in a branch with the lamp around the inner one. With, say, 12 turns in the inner coil, and a possible change of the turns of the outer coil from none to 15 or 16, and passing condenser discharges over an air gap at J with an air blast playing on the spark to prevent continuous arcs, when the condenser charges are furnished by the high potential secondary of an alternating current transformer, the lamp at L would be lighted to a greater or less brilliancy according to the turns of the outer coil in use. In applying the movable wire to the outer coil at a certain point, there is found to be no current passing in the lamp, and on passing this wire either way from this point so as to include more or less of the outer turns, the lamp is lighted with gradually increased brilliancy as the neutral point is more and more departed from. Of course a current indicator, provided it responds to currents of excessive frequency, may be substituted for the lamp. This experiment shows in the clearest manner the fact, that a selective path for the discharges of high potential is obtained in adjusting the relative number of turns in the outer and inner coils.

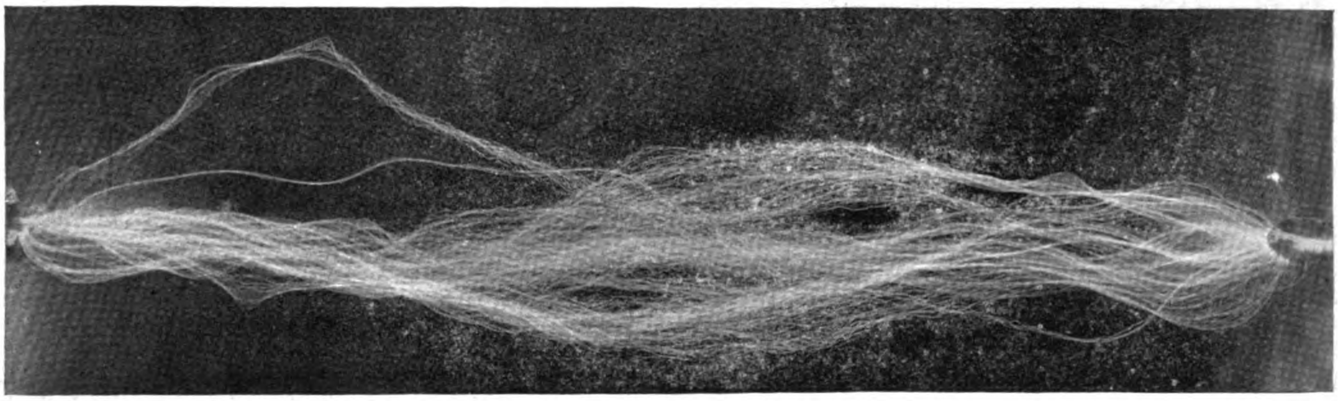


FIG. 4.—DYNAMIC INDUCTION DISCHARGE THROUGH 30 INCHES OF AIR, AT 500,000 VOLTS.

I have in a previous communication stated in what way this combination of inductive coils has been applied as a lightning arrester or protective apparatus for dynamos, motors, transformers, etc. Varying the spark length at J or the condenser capacity does not, so far as has yet been determined, disturb the relations found. It is, of course, necessary that the two coils be well insulated from each other, and this can easily be done by immersion in oil or separating them by glass, hard rubber, or the like.

I will now describe certain forms of apparatus which are adapted for obtaining, at will, very high potential discharges. In fact, I have been able easily to obtain from about 1,600 feet of wire, sparks of over 31 inches between the discharge balls. So far as can be estimated from available data, these sparks are due to potentials of not less than half a million volts.

In Fig. 2, B is a barrel of lubricating oil, an oil of high insulating qualities, being in fact a liquid paraffine. The top of B is open, and in it are immersed the primary and secondary coils P and S, each wound on a paper cylinder. The cylinder on which S is wound is about 3 inches smaller in diameter than the other, and has an external diameter of about 13 inches. It is covered with two layers of silk, and upon this is wound 500 turns of No. 26 cotton-covered wire in one layer with a silk thread between the turns. This layer covers about 20 inches of the length of the cylinder. The terminals of this fine coil are carried out respectively through the lower head and up through the oil above, as will be described.

The primary P consists of fifteen turns of a conductor composed of five rather heavy wires laid alongside, and the connections are made by carrying the terminals outside at O, keeping them about two inches apart. The wire leaving S downward goes to a rod which rests in a cup in the centre of the bottom head of the barrel. This cup has a rod extending down through a glass cylinder filled with oil which dips in a horizontal trough of oil T, through the centre of which is carried a prolongation of this rod to conduct the discharges to the lower discharge terminal D.

The upper end of S is treated in a similar way, passing up through a cork in a glass vessel, such as an inverted bottle with the bottom perforated, then horizontally in the trough T of oil to the sleeve G through which a hollow brass bar D, with rounded ends, may be slid up and down. For this purpose a string and pulley with counter-weight W may be provided. The bar D, should be, say, an inch in diameter to avoid brush discharges from its sides, and in fact, its upper end should be covered with a bottle of oil or have a large polished ball ; otherwise large brush discharges will pass into the air from it. By means of a condenser and spark gap with a blast of air blowing across the gap, the apparatus may be used to obtain the high potential and high frequency sparks. The charging of the condenser is from the secondary of a high potential induction coil given about 15,000 to 20,000 volts, the primary of which coil is fed from alternating current mains. The condenser used in the experiments, consisted of 16 Leyden jars of about a gallon each, which was all there was at command. This will be replaced by a special condenser adapted for such work. The discharges from the apparatus are, as stated, over 31 inches long, and this distance is the maximum that can be given to the space between the terminals as the apparatus is constructed. Fig. 5 shows the actual apparatus.

The power of the discharge is exemplified by the ease with which glass plates are punctured. Heavy pine or even oak boards are perforated and set on fire. The discharges scorch a black line where they pass over a surface of wood, and soften glass where they locate themselves in passing over a sheet. A stick of wood placed between the terminals and joining them, is splintered and torn by the discharge, and is found covered with a fur of fine splinters. Glass vessels are shattered in the line of the discharges, and inflammable matter is set on fire. Perhaps the most beautiful effect is obtained by the insertion of a plate of glass between the electrodes when separated about 24 inches. If the glass be thick enough to resist perforation, the discharges spread all over it and pass around the edges producing an almost indescribably beautiful effect, especially in a feebly lighted room which allows all the minor ramifications of sparks to be seen.

The induction in the fine secondary of the apparatus is about 1,500 to 2,000 volts for each turn which would give 750,000 to 1,000,000 volts total for the 500 turns. But on account of condenser actions absorbing a part of the discharge it is probable that the effective electromotive force between terminals may not much exceed 500,000. We have no ready means of measurement of such pressures. A very simple and inexpensive form of apparatus for obtaining these high potential discharges is shown in Fig. 3. It consists of a wooden trough, the joints of which are capable of holding oil ; its parts may be nailed or screwed together in the ordinary way with shellac or white lead.

The primary coil of ten turns lies against the sides of this trough, and the secondary layer may be an ordinary wire heavily insulated with cotton and wound on a cylinder of paper C or cardboard covered with dry muslin or silk. If the turns are not over six inches in diameter the cotton insulation between turns will suffice, if rather thick, say, $\frac{1}{100}$ of an inch, or over.

The secondary terminals are taken out at the centre of the ends of the cylinder, as shown, and led up through a glass vessel, G, which may be conveniently made of two bottles with the bottoms removed and cemented together ; or a specially blown glass vessel may be used instead. Its object is to hold oil and cover the secondary terminals to a height sufficient to remove them far enough to prevent discharges passing over the surface of the oil in the trough which is used to cover the coils, as indicated. The discharge terminals D D, pass up and outward from the bottles and the sparks are obtained between them. The simplicity of construction is evident, a trough four feet long, will hold a coil capable of giving a spark discharge three feet long. By coupling up two such troughs in tension this effect may doubtless be doubled, if required.

It is important, of course, that all connections, leads from the condenser to the primary coil, etc., be as short and as free from self induction as possible, or the rate of oscillations on which the high inductions depend will be lessened and the effects be weakened to some extent. The potential given by a secondary coil of a certain number of turns depends, of course, on the rapidity of magnetic change and the extent of such change, or maximum densities of field attained. The greater the number of turns in the primary, the greater will be the field strength if the same current flows in every case. But increasing the number of primary turns slows the oscillation rate and diminishes the maximum current value and so diminishes the magnetic density. There is evidently to be selected therefore, for each condenser, that number of turns which will give the highest product of the rate of change and the extent of change or maximum field.

As a striking illustration of the slowing effect of numerous turns of wires on the periodicity or rate of change, it may be mentioned that if, instead of passing the condenser discharges through a coarse coil of few turns, using the spark gap and charging transformer as before, they be passed through a well-insulated coil of many turns of comparatively fine wire, the discharge rate may easily be brought down low enough to cause the spark to whistle along with the sound of the alternating discharges of 125 periodicity used in the charging transformer. The introduction of a well-made iron wire core greatly lowers the tone obtained. It is conceivable that an approximation to music might be obtained from spark discharges sent through coils of such varied inductance as to cause the rates of oscillation to follow those of the musical scale.

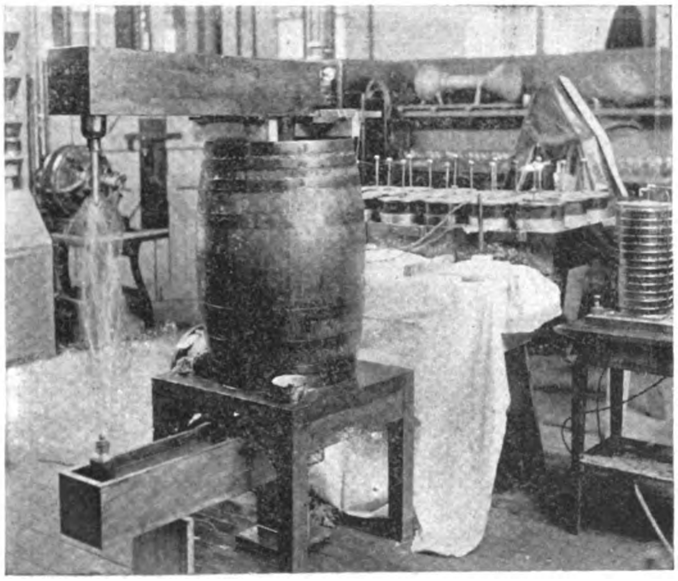


FIG. 5.—APPARATUS FOR HIGH POTENTIAL DISCHARGES.

In the conduct of the experiments on high inductions, which have been described, one cannot fail to be impressed with the capabilities of oil as an insulator. The perforation of two inches of oil between rounded terminals of, say, ½ inch diameter, would seem to demand a potential capable of causing a leap of five feet in air. It appears to be true that edges or points under oil or imbedded in any insulating medium are effective in inducing puncture for the same reasons as they are effective in discharging through air. They act as electric wedges and concentrate the dielectric strains upon those parts of the insulating medium directly in front of such points or edges. Hence, the most perfect insuration to resist puncture in oil or air demands smooth surfaces of as large diameter as possible. This is of course a different matter from insulation resistance or power of resisting leakage.

"IN CHANGE UNCHANGED."

A READER who has every copy of THE ELECTRICAL ENGINEER since April, 1882, writes: "Enclosed please find check for my subscription for the best electrical paper on top of the earth."

BEARING FALSE WITNESS AGAINST ELECTRICITY.

THERE seems to be a growing tendency among insurance companies, or the parties in whose premises disastrous fires have occurred, or the public at large, or possibly our daily newspapers, to make sweeping and, as it were, conclusive assertions, that the damage from fires directly resulted from electric light wires.

Apropos of this we enclose a clipping from the *St. Louis Republic*, relative to a large fire that occurred here yesterday. As stated in the second clipping from the *St. Louis Post Dispatch*, we did the wiring in this building and happen to know that there were no wires within forty feet of the place where the fire started. It is immaterial to us who makes these broadcast statements; they are nevertheless very damaging to our line of business, and to say the least very unjust.

Can't you take this matter up and publish in the columns of your valuable sheet a few lines to serve, as it were, as an antidote for this virulent poison which has been thrown into the public mind? ELECTRICAL SUPPLY CO.,
W. N. MATTHEWS, President.

ST. LOUIS, March 19, 1892.

Personal.

MR. P. J. SHIELS, who has been stenographer for some time past in the office of the *Electrical World* has resigned his position, and will have no further connection with that concern. Mr. Shiels is opening offices in the Bennett Building, corner of Nassau and Ann streets, as a stenographer, typewriter, translator, etc. He is thoroughly familiar with technical work in the electrical field, and is moreover a skilful translator of French and Spanish. Having had opportunities of testing his work, the editors of THE ELECTRICAL ENGINEER can heartily recommend him.

Legal Notes.

PATENTS ON FIBRE RODS.

THE DELAWARE HARD FIBRE CO., Chas. G. Rupert, treasurer, under date of March 12, has issued a special circular, of which the following is a portion:

"We wish to call your attention to U. S. letters patent Nos. 11,173 and 469,238, of which we are sole owners, which cover the mode of making fibre rods as well as the machine for their manufacture.

"We desire to state that we are fully prepared to supply the demand for such fibre rods at reasonable prices, and propose to maintain our rights against infringers. We have accordingly, in pursuance of this policy, to-day brought suit against both the Kartavert Manufacturing Company and the Vulcanized Fibre Company of this city for such infringement, and shall bring such other and further suits as may be necessary to maintain our rights."

THE FINNEY ELECTRIC RAILWAY PATENTS.

THE Pittsburgh *Chronicle Telegraph*, of March 22, had an interesting reference to the Finney patents, owned by the Overhead Conductor Electric Railway Co., in which Westinghouse interests own a majority of the stock. It gives currency to the report that the Thomson-Houston and Edison companies have been desirous to obtain licenses, under royalty, but have not succeeded, and it adds: "The broad character of the Finney invention is shown by the two following claims from one of the patents: 1. The combination, in an electric railway, of a battery or other generator of electricity, an overhead main conductor, a branch conductor connected to a car, and having a traveling contact with the main conductor, an electromotor mounted on the car, and power-transmitting devices connecting the motor shaft to the wheel or axle of the car. 2. In combination with a car motor operated by a leak or branch circuit from a main circuit and regulated by a lever or equivalent device placed on the platform or other accessible part of the car, substantially as and for the purposes described."

STREET CAR MOTORS AT THE CHICAGO ELECTRIC CLUB.

AN interesting discussion was had before the club on March 21, on the subject of singe motors for electric cars, the advocacy of which was undertaken by Mr. E. A. Sperry. Among those who followed him were Mr. W. Le Roy Emmet, who favored the double-motor system, and Messrs. Perry, Sullivan and Arnold.

THE DEPARTMENT OF ELECTRICITY, WORLD'S FAIR.

THE building for "Department J, World's Columbian Exposition," is now rapidly approaching completion and will, when finished, present a strikingly beautiful and harmonious appearance. It is 700 feet long and 345 feet wide, and is appropriately placed in a north and south direction. The general plan, shown in Fig. 1 of the accompanying illustrations, consists of a longitudinal nave 115 feet wide and 114 feet high, crossed by a transept of the same width and height. We have already shown a perspective.

Longitudinal galleries, 115 feet wide, shown in Fig. 2, extend along either side of the building 30 feet above the main floor. These are connected at either end by narrower galleries.

The building will be dedicated on October 12, and exhibits will be received from November 1, 1892, to April 10, 1893, after which date nothing will be admitted. Space not taken possession of on April first will be forfeited.

Exhibitors will not be charged for space, and a limited amount of power will also be furnished gratuitously, while those requiring more can secure it at a fixed price. No single piece of any exhibit of greater weight than 30,000 pounds will be received where machinery is required for its installation. The floor of the building is designed to support 150 pounds to the square foot, and, where exhibits require extra foundations, they are to be built at the expense of the exhibitor.

The designs of all minor details, such as platforms, railings, show cases, partitions, signs, etc., are to be submitted to the Chief of the Department for approval, and will be required to conform to certain rules, artistic and economic, that have been formulated

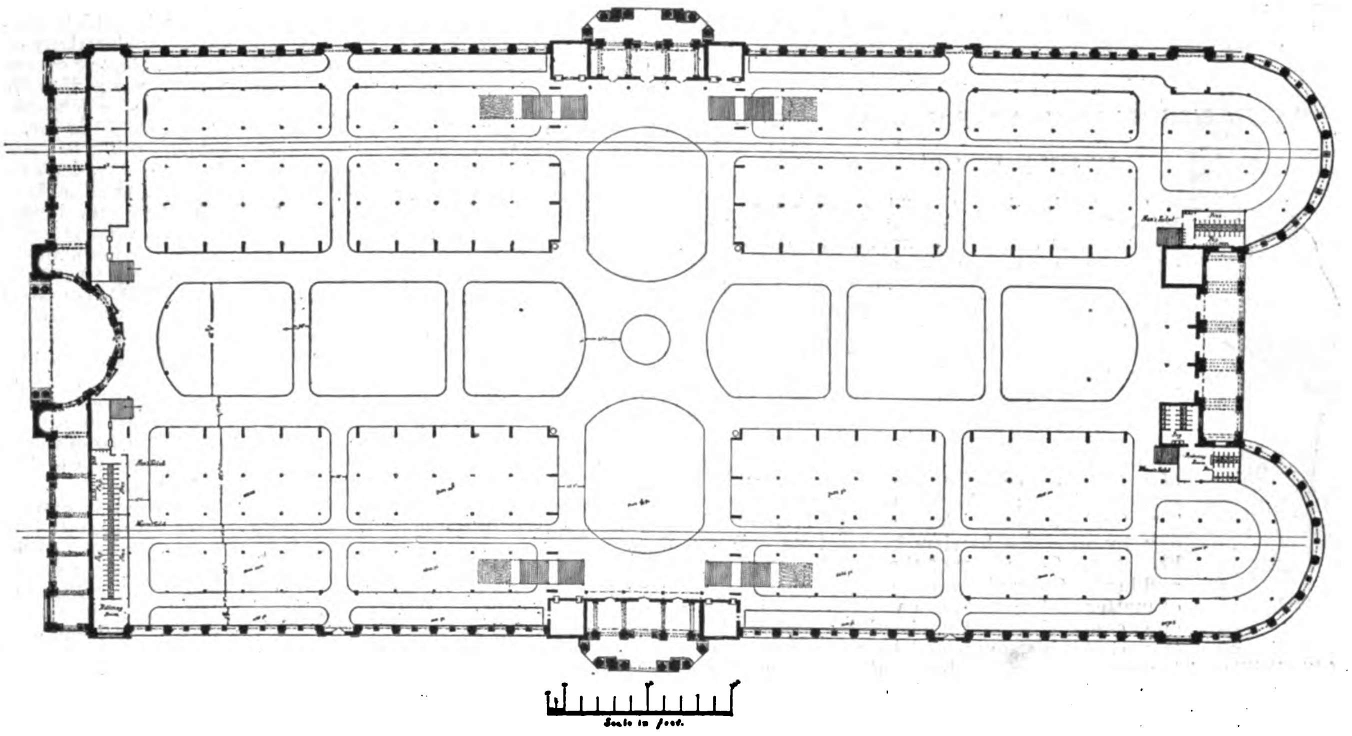


FIG. 1.—GROUND FLOOR, ELECTRICITY BUILDING, WORLD'S FAIR, CHICAGO.

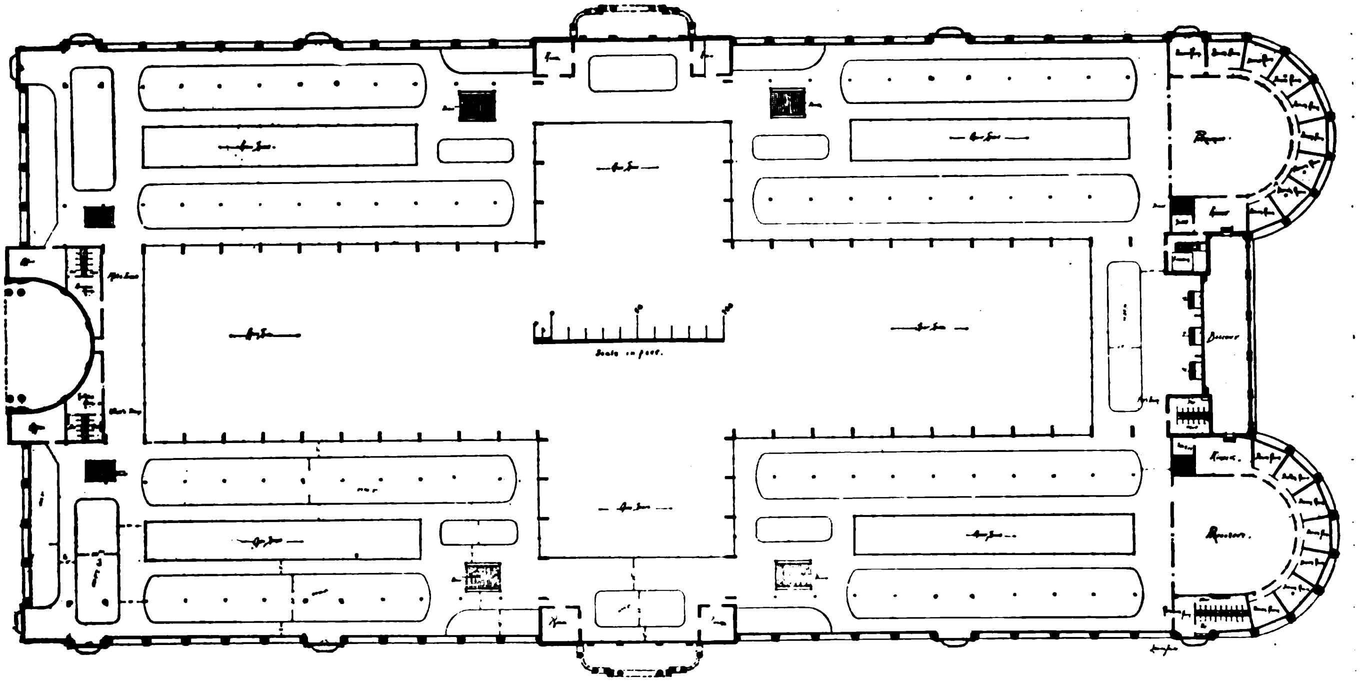


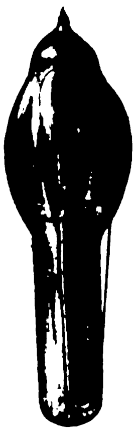
FIG. 2.—GALLERIES, ELECTRICITY BUILDING.

Generators actually operated by steam power will not be exhibited in the Electrical Building, but will be located at the power station, which will also contain the plant which serves the Exposition, while elevators, search lights and other apparatus intended for exhibition but offered for service, may be placed wherever they will be useful, without forfeiting their rights as competitive exhibits.

No duty will be exacted by the Government upon exhibits from foreign countries except in the event of their being sold.

NATURE'S IMMEASURABLE UNUSED FORCE.[1]

BY J. E. H. GORDON.



On Wednesday, the 3d of February, the Royal Institution was crowded with one of the most critical scientific audiences in the world, who were held spellbound for more than two two hours while Mr. Tesla gave an account of his discoveries. Mr. Tesla is a young electrician born at Lika, on the border of Montenegro, and now domiciled in America. The interest of the lecture lay, not in the beautiful experiments with which it was illustrated, nor in the actual facts put forward, but in the hope which it held out that we may now draw back a little further the veil which hides one of the most fascinating mysteries of nature, namely the relations between light and electricity, and between matter and motion. The tendency of modern science is to remove day by day the barriers between its different branches. Our views of the phenomena of light and heat, of electricity and magnetism, and even of matter and motion, are rapidly merging into one general theory of molecular physics, which is perhaps best expressed by the vortex theory of Sir William Thomson. According to this theory the whole of every part of space is filled with a fluid called ether, almost infinitely thin, and almost infinitely elastic. The historic experiments of Faraday interpreted by the mathematical researches of Clerk Maxwell, have demonstrated almost beyond doubt that the same ether whose waves carry light and heat from the sun and stars to the earth, also carries the waves of electric and magnetic induction which follow each outburst of solar activity.

Sir William Thomson holds that all that which we know as matter consists of vortices or whirlpools of this ether, which, from their rapid rotating motion, resist displacement, and therefore show the common properties of hardness and strength in the same way as a spinning top or gyroscope tends to keep its axis in a fixed direction. But whether the molecules or particles of what we know as matter are independent matter, or whether they are ether whirlpools, we know that they keep up an incessent hammering one on another, and thus on everything in space.

Prof. Crookes has shown that the forces contained in this bombardment are immensely greater than any forces we have yet handled, many millions of horse power being contained in an ordinary room. Owing, however, to the forces being in every possible direction they neutralize each other, and no result of them is perceivable to our senses: but if ever we discover how to so direct their courses as to send the majority of them in the same direction, we shall have at our disposal forces as much exceeding any we are now acquainted with as the blow struck by a bullet exceeds the force required to pull the trigger of a gun. In fact, as Mr. Tesla put it in his lecture, "We shall then hook our machinery on to the machinery of Nature." It is because they hold out to us a hope, however distant, of some day so guiding the ether storm, that the experiments of Nikola Tesla are of such transcendent interest and importance.

Prof. Crookes, in his experiments on "radiant matter," has given us the first hint of a method of directing what, for want of more exact acknowledge, we will call the molecules of matter. With the appliances at his command, however, he was unable to impart any great change of direction, but he succeeded in making that change manifest by reducing the disturbing forces acting against his directing force. In other words, he pumped out from glass bulbs and tubes nearly all the air or other gas that they contained, and the comparatively few particles left were then free to travel in any course imparted to them without much change caused by collision with others. This special direction was imparted by means of electricity, and gave us the beautiful phenomena of phosphorescence and radiant matter which are now so well known in these experiments.

By means of suitably shaped terminals a stream of molecules is focused on a given point. If a piece of carbon or platinum is placed at that point it becomes white hot under the bombardment from identically the same cause which induces a sheet of flame to appear when a cannon shot strikes an iron target. If a ruby or other phosphorescent material is placed there it glows with its characteristic color, and if a little delicately balanced vane or windmill is placed so that the stream is directed on one side of its fans, it rapidly revolves. The forces available in these experiments were, however, almost indefinitely small, being, as it were, merely flying spray from the great torrent into which we have not yet been able to penetrate.

Now for the advances made by Tesla.

In all the above experiments the electricity by which the directing force was imparted to the molecules was electricity of a comparatively slow alternation period, namely, electric currents oscillating about 80 to 100 times per second. It was as if we had tried to ventilate a room by causing a man to walk slowly through it with an umbrella. He would undoubtedly move the air, but would move it so slowly that ordinary methods would be insufficient to enable us to perceive its motion. In order to cause a rush of air we must put up a rapidly moving fan or other suitable machinery. Mr. Tesla, seeing this, abandoned the ordinary dynamo, which, as we have already noted, gives about 80 alternations per second, and the ordinary induction coil, which gives about the same number, and constructed a dynamo which gives 20,000 alternations per second, and by connecting this to suitable condensers he multiplied its alternations until they reached 1,000,000 or 1,500,000 per second.

Then at once an entire set of new phenomena appeared, and the experimenter entered a region of mystery and hope. One of the first things noticed was that, either because these vibrations are too rapid to excite corresponding vibrations in the nerves of the body, or from some other cause, no shock is felt from the current; and that though an ordinary current at 2,000 volts will kill, yet this current at 250,000 volts cannot be felt at all.

It was also found that the vibrations keep time in some unknown way with the vibrations of solid matter. Vulcanite is one of the best insulators known, and will entirely stop any ordinary current or discharge, but the stream of sparks between two poles with this current pours through a thick sheet of vulcanite as easily or even with greater ease than through air. It does not perforate it in any way, but passes through it as light passes through glass.

All the "Crookes" phenomena of radiant matter are almost indefinitely increased; it is the blow of mitrailleuse bullets compared to the blow of an air ball thrown against the wind. The forces can be directed for a considerable distance through space without the aid of wires. Electric lamps light easily when attached to one single wire and require no return conductor; and, more wonderful still, if metal plates are fixed on the roof and walls of a room and connected to the terminals, the whole atmosphere of that room, whether it be ether or whether it be particles of common matter, is thrown into a state of storm and agitation which can be be at once made perceptible by bringing into the space tubes or globes from which the air has been partially exhausted. Such tubes, though without any metallic connections, yet glow and throb as if powerful currents of electricity were being sent through them from an ordinary induction coil. A Crookes radiometer placed near a metal conductor from which neither spark nor glow is perceptible, yet rotates as if it were placed near a lamp or heated body, but rotates in the wrong direction, and a true flame burns in which nothing is consumed.

When the discharge issues from a suitable terminal it has the appearance and roaring sound of a gas flame burning under too high a pressure, and gives off a considerable heat; to use Mr. Tesla's words again: "This is not unexpected, as all the force and heat in the universe is due to the falling together of lifted weights, and the same result is produced whether these weights have been lifted apart by chemical energy, and rest in the form of oxygen and hydrogen ready to combine chemically, or in the form of energy or moving molecules directed by the electric current."

Should the application of Mr. Tesla's results ever fulfil the bold dreams of scientific imagination, we shall see a social and political change at least as important as that caused by the railway system or the electric telegraph. Most manual labor will become unnecessary, as unlimited power will be available at every man's hand. Engineering works will be able to be carried out on a far greater scale than has yet been even contemplated, and doubtless a corresponding era of material prosperity will set in; but, whether these dreams are ever fulfilled or not, few who attended Mr. Tesla's lecture will forget the possibilities which seemed to open to their minds when they saw a living man standing in the midst of the electric storm, receiving unharmed in his hands flashes of veritable lightning, and waving above his head a tube, through which the very life blood of creation pulsed, in waves of purple fire.

A NEW STATION FOR WILLIMANTIC, CONN.

It is expected that the new station of the Citizen's Gas and Electric Co. will be in operation in a few days. The building is of brick, two stories high, and was begun last November when the above company bought the interest of the Willimantic Electric Light Co. The new officers are E. S. Bois, president; Julius Pinney, secretary; O. H. K. Risley, treasurer.

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[1] *Nineteenth Century.*

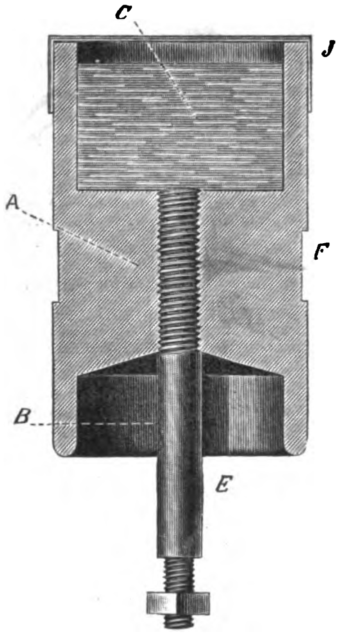
THE HEWETT POROUS OIL INSULATOR.

BY

RJ Hewett

Believing that the problem of a successful open conduit trolley system for street car propulsion depends in a measure upon efficient insulation of the naked conductor, the writer has worked out this invention with a view of filling such requirements. In looking at the conditions which exist in an open conduit, we see that the humidity of the atmosphere will always be greater than in the open air above ground. Aside from this, in dry weather a certain quantity of dust will find its way into the conduit and adhere to the insulators. From this the writer was led to the conclusion that an insulator to be used under such adverse conditions should be designed so as to obviate these difficulties as much as possible.

In an article on oil insulators for high tension currents, by F. L. Pope, which appeared in The Electrical Engineer of October 25, 1891, there was given a brief description of an oil insulator invented and patented by the writer. The process of development has produced forms of insulators much superior to the original ones, among them being the improved form shown in section in the accompanying engraving.



The Hewett Porous Oil Insulator.

The body of the insulator A is composed of wood, and has the usual bell shape at the bottom. The upper part of the insulator is formed into a cup C, which is filled with insulating oil, which saturates the entire porous body of the insulator and passes out in the bell B, the crown of which is beveled, as shown. The beveled shape of the crown causes the oil to run outward to the rim, down which it flows in a thin film to the edge, where it drips off. The bell of the insulator is thus supplied with a constantly renewed surface of oil, which carries away any particles of dirt that may lodge upon it, and thus prevents the formation of a continuous film of moisture even in the most humid condition of the atmosphere. A cap J covering the oil cup can be removed when necessary to refill the cup with oil. A groove F is provided for receiving a clasp, by means of which the insulator is attached to the conduit or manhole. To the end of the shank E is attached the wireholder.

Experimental work has shown that wood is more suitable than porous earthenware. Aside from being cheaper and less liable to breakage, it is more suitable on account of its peculiar porous structure, it being quite porous in the direction of its fibrous structure, but only slightly porous in a transverse direction. This peculiar porous property of wood causes the oil to pass out of the body of the insulator more freely at the place where it is most needed, that is, in the bell.

Woods of a rather close grain, such as wild cherry and soft maple, are most suitable. The wood is split and cut into billets of suitable size, and treated by a special process which drives out all moisture, resin and other volatile matter, and thoroughly shrinks it so that no further shrinkage can take place. After this the billets are turned down to the proper shape and the shank put in place. This special treatment obviously improves the insulating qualities of the insulator.

The insulator is applicable to other cases of a similar nature, such as tunnels and mines worked by electric mining locomotives and other cases where naked wires are to be insulated under adverse conditions of atmospheric humidity.

Letters to the Editor.

ECONOMY IN ARC LIGHT WIRING.

The interesting paper under the above caption by Mr. Sharpsteen in your issue of March 16, suggests to us the propriety of referring to the method by which this company accomplishes the same object, viz.: the simplification of circuits and consequent saving of initial capital as well as subsequent maintenance.

We have endeavored to approach this subject in the spirit of engineers, not of mere salesmen. The operating electric light companies both in the larger cities and smaller towns seemed to us to be between the horns of a dilemma; either they had to run separate circuits for each class of lights or else burn the short-term lights until those of the longest term were cut out. Both methods were wasteful, and it was only a question as to which would cost the more in the long run.

To meet the contingency we applied our principle of "Individual Selection" and worked out a system of "Individual Cut-Outs" by means of which any loop of lights or motors on a given circuit could be cut out or in at any time from the central station without affecting others on the same lines. Adapting this plan to the case cited by Mr. Sharpsteen, we would dispense with the third wire of a larger capacity and run a No. 12 wire on which the locks and cut-outs would be placed. The commercial and city lamps would be put on the same circuit; the former grouped into convenient classes, say 9 o'clock, 10 o'clock and midnight or any other arrangement called for by contract requirements. One of our combined locks and cut-outs would be placed in each loop, and each set of lights cut out at its contract hour by the central station operator using the transmitter provided for that purpose. This would leave the city lights burning alone when the last commercial lamps were extinguished and allow the commercial lights to be started an hour or two earlier than the city lamps, as is necessary in most cases, and thus effect a saving of current. In the same manner, each loop would be cut in again when its hour arrived. If it should happen that the lights of one class were so separated that they could not be advantageously brought into one group, they could be divided into sub-loops and a switch (as distinguished from the combined lock and cut-out) be introduced in each one. In this case the one lock would work all the switches on its own loop together. The extra expense would be confined to a slightly greater length of No. 12 wire, which is the size used in connecting up our locks and switches, all of which are operated with a single line.

If a comparison be made between this system and the method of wiring usually adopted, ours will be found to possess some very positive advantages both on the score of economy and otherwise. Those who have been forced, by unsympathetic municipal authorities, to go underground with their wires, will find that they can save many a mile of costly feeders, while those to whom the air is yet free are enabled to run a single feeder to distant points of distribution and there divide their circuit into loops controlled at pleasure from the central station. Many modifications of this use are feasible, for our object has been to furnish a system elastic enough to be of general utility. The vital feature is that the power of selection is placed with the central station and its control of individual lamps, motors or groups made absolute, irrespective of distance or variety of class.

Our conviction that we are giving electrical engineers as well as light and power companies an effective means of simplifying and consolidating their services is our excuse for encroaching upon your space, and at the same time showing as marked an advance over the plan sugested by Mr. Sharpsteen as is his over the well-known metallic system for the control of each bank of lights.

Electric Secret Service Company,
By C. P. Mackie, Gen. Manager.

New York City.

THE TWO DROMIOS.

Having learned of another of the samena me engaged in electrical work, I beg to state that hereafter I shall sign myself as below.

If you will kindly publish the above, you will confer upon us both a great favor.

H. Robinson Wellman.

94 Hough Avenue,
Cleveland, O., March 22, 1892.

A U. S. ELECTRICAL EXPERIMENT STATION FOR AGRICULTURE.

I forward to your address a copy of the bill to establish an electrical experiment station. Our Kansas people have been experimenting a good deal in this line, and have come to the conclusion that, with a little help on the part of the Government, great things will result in the direction of the use of electricity as a propelling power as applied to farm implements and machinery. Personally, I have long been of opinion that this can be done. We are now using storage batteries in the propulsion of railway cars and of various other classes of machinery. I can see no good reason why we cannot do the same thing as to farm machinery, and in that way much cheapen production.

W. A. PEFFER,
U. S. Senator.

WASHINGTON, UNITED STATES SENATE, March 22, 1892.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 15, 1892.

Accumulators :—

Secondary Battery, G. F. Parker & C. E. Crapo, 470,701. Filed April 10, 1891.

Employs a dome-shaped metallic plate provided with tapering recesses for the active material extending through the plate and arranged in the exciting liquid in a horizontal position, the concave side of the plate being downward for the retention of the gases.

Alarms and Signals :—

Police and Fire-Alarm Signaling Apparatus, L. B. Firman, 470,666. Filed April 1, 1889.

A multiple signal box designed to send emergency signals and also the customary police signals.

Combined Police and Fire-Alarm Signal Apparatus, L. B. Firman, 470,667. Filed Nov. 28, 1890.

A combined fire-alarm and police circuit system.

Tell-Tale Device for Electric Circuits, E. Tregoning, 470,722. Filed Oct. 2, 1891.

Consists of a solenoid having a movable tubular core provided with means for closing an annunciator circuit.

Electrical Hose-Signaling Apparatus, W. Fowler, 470,752. Filed Aug. 24, 1891.

Provides means whereby signals may be instantly passed back and forth between the men at the fire engine and those at the nozzle of the hose.

Appointment Signal for Telephone, S. W. Gray, 470,786. Filed May 12, 1891.

An arrangement by which, in the absence of the person called, the time of his return may be indicated by means of a signal in the receiver at the transmitting station without the use of an additional bell, but merely by placing the signal mechanism in circuit with said receiver and a source of electricity.

Switch for Electric Sigaling Apparatus, L. Sellner, 470,798. Filed Oct. 17, 1891.

A switch for signaling apparatus in which the signals are produced by means of multi-colored incandescent lamps, intermittingly brought to incandescence.

Electric Railway-Signal, A. J. Wilson, 470,813. Filed Nov. 9, 1991.

An automatic block signal for railways.

Time Indicator and Alarm, H. Bennett, 470,816. Filed Sept. 1, 1891.

Annunciator, A. H. Brintnell, 470,831. Filed April 11, 1891.

A thermostat which, in addition to a fire-alarm, will also act as an alarm of warning in case of incipient heat.

Employee's Time-Recorder, W. Lucas and T. A. Garrett, 470,810. Filed April 21, 1891.

Conductors, Conduits and Insulators :—

Insulation for Electric Wires, S. Vanstone, 470,883. Filed Mar. 21, 1890.

An insulation consisting of abutting longitudinally divided sections of rigid non-conducting material, the abutting ends forming a socket joint.

Electric Conductor, T. A. Edison, 470,924. Filed Sept. 30. 1887.

Has for its main feature the use of an insulating covering, consisting of a mixture of rubber with an infusible material in the form of a powder.

Underground Electric Conduit, J. F. Munsie, 470,896. Filed Oct. 9, 1889.

Distribution:—

Transmission of Electrical Energy to a Distance, M. Deprez and J. Carpentier, 470,865. Filed Nov. 27, 1888.

Claim 1 follows:

The improvement in the art of transmitting electrical energy to, and utilizing it at a distance from the source, which consists in generating maintained and practically uniform currents of high tension at one station, and sending the same over a line of conductors to another station, and generating maintained and practically uniform currents of lower tension at the second station by the inductive influence of the high tension currents.

Dynamos and Motors:—

Field Magnet for Dynamos, G. E. Dorman, 470,749. Filed Dec. 17, 1890.

Consists of a series of short over-lapping arc-shaped segments with inwardly projecting ends in alignment so as to form a circular field magnet with inwardly projecting pole-pieces.

Dynamo, W. H. Elkins, 470,784. Filed June 29, 1891.

A dynamo in which the current taken from the armature is divided, one portion going through some of the field coils and the rest through other field coils before the two divisions unite to form the current through the work circuit.

Dynamo, W. H. Elkins, 470,785. Filed July 11, 1891.

Similar to No. 470,784.

Electric Railway Motor, F. O. Blackwell, 470,817. Filed Aug. 31, 1889.

A motor journaled directly upon the axles of the vehicles between the wheels, gearing without the intervention of the countershaft and having sufficient torque to propel the vehicle under all circumstances.

Dynamo-Electric Machine or Motor, T. A. Edison, 470,926. Filed Feb. 24, 1891.

Employs a magnet pole-piece consisting of several distinct layers of iron or steel united for a part of their length in an integral mass.

Alternating Current Generator, T. A. Edison, 470,928. Filed Aug. 25, 1891.

Claim 3 follows:

In an electromagnetic machine a circular field magnet built up of overlapping plates, said plates having bodies and projecting legs which constitute the pole-pieces of the field magnet, and being in contact with each other for a portion only of their length.

Dynamo-Electric Machine, T. A. Edison, 470,930. Filed Oct. 10, 1891.

Employs an armature coil covering the entire surface of the core, a commutator having a number of conducting blocks, a series of field magnets forming a succession of alternating like and unlike fields, commutator connections between all portions of the armature coils situated in corresponding magnetic fields and the same commutator blocks, whereby a continuous current is produced, the commutator brushes taking current from and delivering current to all parts of said coil.

Galvanic and Thermo-Electric Batteries :

Galvanic Battery, F. H. Root, 470,792. Filed Nov. 5, 1888.

Comprises a cell closed at its top and provided with a vent tube, a packing of mineral fibre arranged within the cell, a chloride of silver electrode embedded within the packing, a zinc electrode surrounding the packing, and an excitant consisting of a caustic solution.

Lamps and Appurtenances :

Arc Light Hanger, C. A. Pfluger, 470,766. Filed May 15, 1891.

Manufacture of Filaments for Incandescent Lamps, T. A. Edison, 470,922. Filed Oct. 10, 1883.

Method of forming blanks for filaments consisting in treating separately two or more sheets of paper with hydrofluoric acid to form a cementing material and then placing the sheets together.

Manufacture of Filaments for Incandescent Electric Lamps, T. A. Edison, 470,925. Filed Mar. 20, 1880.

Claim 1 follows:

A filament for forming the carbon incandescing conductor of an electric lamp, consisting of a number of fine filaments welded together by a carbonizible cementing substance.

Miscellaneous :—

Electric Connector, W. H. Garland, 470,820. Filed Nov. 23, 1891.

A binding strip consisting of a short section of wire having two terminal sleeves adapted to slip over the ends of such strip and be inserted in holes at the ends of the rails.

Magnetic Separator, T. A. Edison, 470,929. Filed Oct. 1, 1891.

Appliance for Sighting Guns, L. M. von Markhof, 470,942. Filed Nov. 6, 1890.

A ship's gun, to which is connected a normally interrupted electric firing or alarm circuit.

Electric Elevator, R. C. Smith, 471,063. Filed Nov. 11, 1891.

Relates to means for operating an electric elevator at different speeds.

Electric Elevator, R. C. Smith, 471,064. Filed Nov. 30, 1891.

Similar to No. 471,063.

Railways and Appliances :—

Electric Railway, E. M. Bentley, 470,654. Filed Dec. 11, 1885.

Claim 1 follows:

The combination with two electric railways having separate sources of current, of a section of conductor common to both of said railways, but insulated from the main conductors of one road.

Motor for Electric Cars, F. O. Blackwell, 470,656. Filed Dec. 4, 1890.

Claim 2 follows:

The combination of an electric motor geared to the axle of a truck and having flat field magnets, recessed transversely with coil windings surrounding the armature disposed in such recesses and removable therefrom.

Contact Device for Electric Railways, F. O. Blackwell, 470,657. Filed Jan. 26, 1891.

Consists of a supply conductor inclosed in a slotted conduit and a contact device comprising a shank extending through the slot and a pivoted spring actuated contact maker furnishing means for supporting the contact device on the conductor.

Railroad Circuit-Closer, F. E. Kinsman, 470,806. Filed July 30, 1891.

Has for its object a device which shall not be subject to interference from the presence of frogs, crossings or switches on the line of rails over which the vehicle travels.

Railway Time-Signal, H. Gosman, 470,821. Filed May 23, 1891.

Electric Wire-Support, F. O. Blackwell, 470,844. Filed June 17, 1889.

Consists of a trolley wire hanger of malleable material having a groove at one side to contain the line wire and projecting pieces that clamp over the wire holding it firmply to the supporter.

Railway-Signaling, T. A. Edison, 470,923. Filed Aug. 19, 1887.

Relates to the operation of electrically controlled signals upon railway lines and has for its object the elimination of the making and breaking contacts for this purpose.

Driving Mechanism for Cars, T. A. Edison, 470,927. Filed Mar. 26, 1891.

Driving mechanism for electric cars consisting of the use of sprocket wheels and link belts.

Switches and Cut-Outs :—

Protector for Electrical Apparatus, C. H. Morse, 470,697. Filed Jan. 12, 1892.

Consists of two independent helices on opposite sides of the circuit including the apparatus to be protected, an armature extending across the cores of said helices, two contacts respectively connected to the opposite sides of said circuit, and one contact connected to the earth, together with a short circuiting and grounding weight normally locked to said armature.

Lightning Arrester, E. Thomson, 470,721. Filed Dec. 26, 1889.

Claim 5 follows:

The combination with the arcing electrodes and arc-rupturing magnet of a surrounding cage or barrier arranged around the electrodes and provided with a number of discharge openings.

Lightning Arrester, G. M. Bacon, 470,736. Filed Aug. 10, 1891.

Employs a series of carbon points so arranged as to be automatically thrown in and out of circuit of the discharge.

Electric Switch, S. Deacon, 470,748. Filed Mar. 18, 1889.

Has for its object to secure a quick movement of the parts in changing from one position to the other.

Circuit-Interrupting Device, A. Wurts, 470,772. Filed Nov. 25, 1891.

Claim 4 follows:

The combination of two cylinders of brass normally resting in contact with each other, yielding thermostatic supports for the respective cylinders and circuit connections through said supports with said electrodes.

Circuit-Interrupting Device, A. Wurts, 470,773. Filed Dec. 1, 1891.

Claim 1 follows:

An arc-interrupting device consisting of two or more electrodes of zinc, antimony, or compounds thereof, or other materials having a non-condensing, vaporous oxide.

Apparatus for Protecting Circuits, A. Wurts, 470,774. Filed Dec. 16, 1891.

Employs in connection with the dynamo circuit a static discharge circuit and a circuit controller alternately connecting the poles of the dynamo with the discharge circuit.

Electric Switch, H. Moore and O. O. Jarrard, 470,790. Filed Sept. 4, 1891.

A quick-breaking switch simple in its construction and efficient and durable in use.

Contact Maker, D. Draper, 470,994. Filed Sept. 30, 1891.

A positive contact maker for use in clocks, meteorological instruments, etc.

Telegraphs :—

Printing-Telegraph, E. J. Silkman, 470,768. Filed Apr. 16, 1891.

A page-printing telegraph in which two duplicate electrically actuated typewriting machines are so arranged that the transmitting operation can simultaneously duplicate the message at his own and at the receiving station by means of a single connecting line wire.

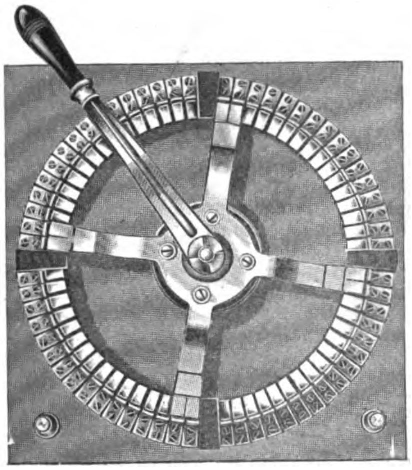
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Persistant advertising makes a permanent business.

THE EDISON STAGE REGULATING SWITCH.

THE EDISON GENERAL ELECTRIC COMPANY has brought out a new stage regulator switch shown in the accompanying illustration, by means of which gradations of light are obtained delicate enough to satisfy even the most fastidious of stage managers. This switch mounted on a slate base, consists of fifty clips arranged in a circle in four divided quadrants with a four-armed contact passing over them, and engaging in a clip every quarter width of the clip. Contact over the entire fifty clips is made by a movement of the switch handle through an angle of 45 degrees only, instead of through 120 degrees, as in all other stage regulators yet devised, and thus the speed of the operation is considerably increased. These switches are either directly mounted on the sides or the top of the fireproof stage regulators, or are mounted separately upon a switchboard and connected with the regulators by means of regular fireproof cables made up of the strands of the connecting wires. They can also be arranged in a special frame in such a manner that the handles can be worked separately, or, connected together, be all operated as one unit.



THE EDISON STAGE REGULATING SWITCH.

THE ILLINOIS ELECTRIC LAMP COMPANY.

THIS company has been organized under the laws of the State of Illinois, with a capital stock of $25,000, all paid up. Chas. M. Howell is president, C. J. Laughren is secretary and treasurer, and J. F. Schaefer superintendent, the original manufacturer of the Jewel incandescent lamp, which has acquired an enviable reputation with the public, and a man who is one of the oldest lamp makers in the country and has done considerable in improvements on lamps as well as on apparatus to manufacture lamps. Attention is called to the announcement in our advertising pages this week. The company's factory is now in operation, located in the business centre of Chicago with a capacity of about 1,000 lamps per day. They furnish lamps of any candlepower and voltage and to fit all sockets. Three Kester dynamos generate the necessary current of different potentials for the production of the filaments and the testing of all lamps. Three large-size Clayton air compressors are used to act as mechanical vacuum pumps, and 40 Schaefer automatic mercury pumps are used to exhaust the lamps,

THE "UTICA" BELL.

A NOVEL bell is that which the Utica Fire Alarm Telegraph Co. are just introducing. It is reliable and efficient and is made to sell at a reasonable price. Unlike most inexpensive bells this one is firmly secured to an iron back and is provided with a metal cover nicely nickle-plated or ornamented as desired. An entirely new feature in these bells is that the position of the magnet is such that both poles have equal power, thus requiring less battery. This company also manufacture a most desirable annunciator and guest return call system. The Plaza Hotel, New York, is equipped throughout with this system, which is giving excellent satisfaction.

LIGHTING AT DANBURY, CONN.

THE DANBURY AND BETHEL GAS AND ELECTRIC LIGHT CO. are about to remove to their new brick station. It is a feature of interest that all their steam engines will be replaced by three Otto gas engines of 100 H. P. each, consuming "producer gas" as fuel.

The local public are said much to prefer arc lights hung low on mast-arms, to clusters on iron towers.

Mr. Charles H. Merrit is president; Mr. H. Williams, treasurer, and Mr. G. E. Cowperthwait, secretary and superintendent of the company.

A DECISION IN FAVOR OF THE CONSOLIDATED ELECTRIC STORAGE CO.

JUDGE GREEN, of the United States Court for the District of New Jersey, last week handed down a decision in the case of the Consolidated Electric Storage Co. against the Accumulator Company, in which he found for the complainants and ordered that an injunction issue against the defendant. The injunction was issued March 19.

It will be remembered that the complainants above obtained a perpetual injunction last December against the Electrical Accumulator Company of New York. This company, however, has ceased to exist any longer, and was succeeded nearly two years ago by the Accumulator Company which is incorporated in New Jersey. The complainants above were therefore compelled to go before the United States Circuit Court in New Jersey in order to obtain an injunction against the Accumulator Company. The argument was had before Judge Green on the 7th of January last. This is the fourth decision sustaining the patents of the Consolidated Electric Storage Company, to wit, the Brush patents.

H. W. JOHNS MANUFACTURING CO.

THE consolidation of the Gould & Watson Co., of Boston, with the Johns-Pratt Co., of Hartford, was consummated on the 22d inst. The mica insulation made by the Gould & Watson Co. will now be manufactured at the Hartford factory of the Johns-Pratt Co. This company will hereafter make the "Vulcabeston," "Monarch" and "Mica" insulations. The H. W. Johns Manufacturing Co., of New York, Boston, Chicago, Philadelphia and Atlanta, will continue as selling agents.

CENTRAL ELECTRIC CO.

SINCE the Central Electric Company took the agency for the Interior Conduit & Insulation Company, they have been overwhelmed with orders, the largest buildings in Chicago, St. Louis and Kansas City being equipped and now in course of construction. The business in this department of the Central Electric Company bids fair to be one of their prominent features.

The Central Electric Company report activity in their pin and bracket department, their factory at Columbia City being in full operation, and the goods being sent far and near in carload lots. The pin and bracket made by this firm is of approved quality, and has a steady demand.

PATENTS ON BATTERY CARBONS.

THE NEW YORK CARBON WORKS, of 18 Cortlandt street, have recently issued the following notice:

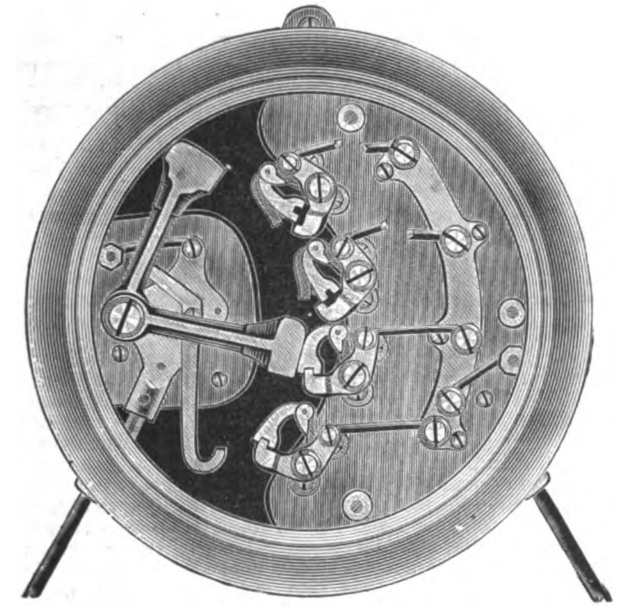
"For the protection of manufacturers, dealers and users of carbon cylinder batteries, we beg to notify all interested, that we have secured from Mr. Chas. W. Holtzer, the sole and exclusive right to manufacture carbon cylinders or cups, under his patent, No. 327,878, dated October 6, 1885; all cylinders will bear date of patent, also our trade mark, thereby protecting all users of same from infringement."

With regard to the above, the Fitch Battery & Electric Co., of Oneida, N. Y., have issued the following:

"Referring to the enclosed notice, we hereby inform our patrons and the trade in general that all carbon cylinders furnished by us are manufactured under authority of the Holtzer patent, and that in using our battery no liability for infringement is incurred."

THE BOSSERT AUTOMATIC MAGAZINE FUSE BOX.

As fuses are liable to be blown at any time, it becomes a matter of importance to replace them quickly in order to avoid interruptions in the lighting or motor service. To effect the rapid substitution of a new fuse automatically, the Utica Electrical Manufacturing Supply Co., of Utica, N. Y., have brought out the automatic magazine fuse box illustrated in the accompanying engraving. This shows the fuse box with the two upper fuses burnt, and, as will be readily seen, as soon as one fuse is melted, another is, by gravity, thrown automatically in circuit. This it will do eight times before it is necessary to replace a fuse.



Bossert Automatic Magazine Fuse Box.

As soon as the four upper fuses are "blown" the first contact arm will be out of circuit and will throw the second arm automatically into circuit, thus giving a second magazine with four additional fuses. After the eight fuses in the magazine are blown in, there are still two main fuses which can be seen at the extreme right and left and connecting the circuit and magazine with a resistance coil placed in a circle on the inside of the case. These two fuses will eventually, if the circuit remains overloaded, blow also and open the circuit. There is no arcing when the fuse blows, because the instant the fuse melts, the current will make a circuit through the main fuses and resistance coil and take its regular course again as quick as contact is made with the fuse. The whole operation of "break" and "make" contacts is done so quickly that the eye can hardly perceive it.

To re-fuse the magazine it is only necessary to take off the brass nuts, seen at the extreme upper, lower and right-hand sides, loosen the set-screw next to the main fuse, and remove the line wire connected with the magazine; then the magagine can be readily taken out to re-fuse; to replace, both arms are moved up before putting the magazine in place, the circuit wire again connected and all is now ready for operation. As will be seen there are no magnets employed which might burn out and would entail extra work on the current. The contacts and conductors are made of bronze metal and of ample proportions, and the workmanship is first class in every respect. It can be used on either primary, secondary, or direct circuits.

Every station manager will readily see the benefit arising from the use of these magazine fuse boxes as they obviate to a great extent the dissatisfaction of customers and "cutting" of bills on account of lights being out caused by the melting of one fuse, a small matter apparently, but very often of large consequence. It will avoid the dangerous and risky work of linemen in climbing poles at night on a still hunt for the burnt fuse, trying to replace it while wires are alive. In short it will, if used on branches and centres of distribution, be a great boon to every one furnishing electricity for lighting or power purposes. The carrying capacity of the above described magazine fuse box is from 1 to 30 amperes. Special sizes are made to order.

THE SOUTHERN ELECTRIC CO.

Announcement is made by the Southern Electric Co., of Baltimore, Md., of the fact that it has secured the services of Mr. P. H. Alexander, of New York, as consulting engineer. It is now putting a large number of meritorious novelties on the market.

THE EICKEMEYER-FIELD STREET CAR MOTORS.

The following letter from Mr. N. B. Ream, of the Illinois Central Railroad, relates to the operation of the Eickemeyer-Field street car motors. This letter refers to the operation of the first large installation of standard double-connected motors made by this company:

Room 1163 The Rookery,
Chicago, March 14, 1892.

Mr. N. P. Otis,
New York City.

Dear Sir:—

In reply to yours of the 12th inst., would say, we have used the Eickemeyer-Field Motor on the Toledo Consolidated Street Railroads for the past year, and now have eleven in use, giving good satisfaction. They are simple in construction, and having no gears and few parts, and being in every way so well protected repairs are light, and hindrance to operation reduced to a small factor. The amount of current required in their operation is less than any motors we have had experience with, and when connected with both axles, we find them very efficient on curves and grades, and in pulling trailers. In our experience we are led to believe the Eickemeyer-Field motor to be in advance for economy as to power, repairs, and in efficiency, and to anyone interested in electric roads would say that it will well repay a visit to Toledo, where they can fully investigate their operation. We have been so favorably impressed with their operation that we have just placed an order for eleven more to be delivered by June 1st next.

(Signed) N. B. Ream,
President of the Toledo Consolidated Street Railway Co.

These motors are now regularly furnished by the Eickemeyer-Field Company, of Yonkers, N. Y.

THE ROY VALVE.

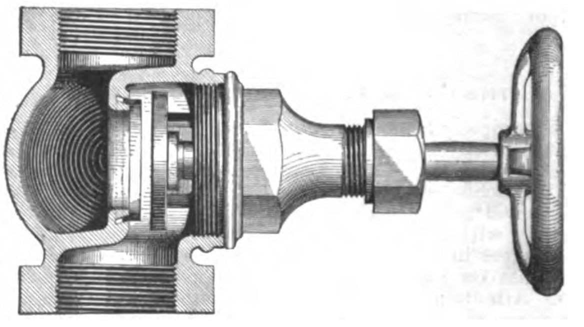
The accompanying illustration shows a new form of tight valve recently introduced by the Roy Valve Company, of 15 Cortlandt street, this city, which, the manufacturers claim, overcomes a number of difficulties met with in practice, and possesses numerous original features peculiar to itself.

It contains a method of making a joint that is a radical departure from the usual method, in a valve body, and assures a tight joint and makes a simple metallic joint which combines the essential features of a ball and socket, and of the expanded boiler tube joint.

It is simply a jointless ring of expansive material, inserted in the body, and as simple in application as a washer, resting on a conical base and making contact on its entire inner edge. When a pressure is put on the upper edge of the ring by means of a flat disc, the ring is forced outward and drawn inward to fill the depressions. The plane of the top surface of the ring remains undisturbed, but free to move laterally on the face of the disc. It is obvious that an extraordinary degree of distortion is provided for.

The ring is placed in the recess intended for its reception in the valve body, and the bonnet is then screwed down in the usual manner. As the circumference of the base of the recess is greater than its entrance, it follows that the ring will assume a degree of expansion similar to the base of the cone, and the elasticity of the ring in combination with the conical base of the valve, with the flat disc, will compensate for the usual distortion met with in practice.

The application of the ring is quickly made, and its removal, if injured by scale or grit, is by a pair of plyers, or similar means that will collapse the ring to a slight extent inwardly, and thus at once free it from the recess.



The Roy Valve.

Its continuous line of contact affords no outlet for the escape of fluid or gas, as is usual with threaded joints, and will, no doubt, with the other original features of this valve receive the endorsement of the engineering profession.

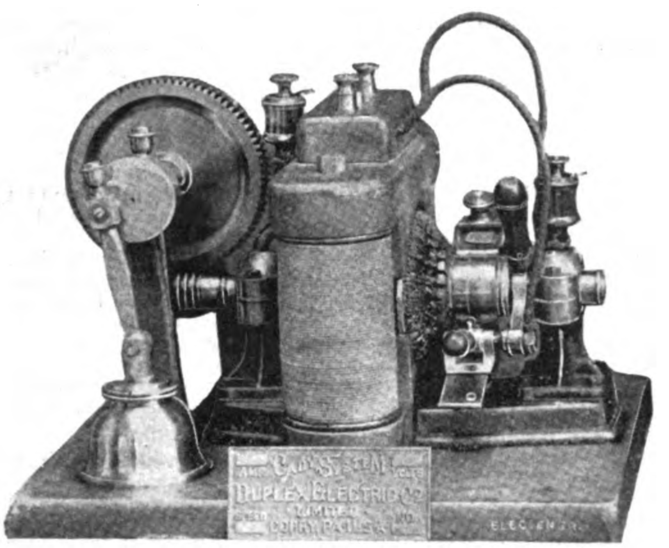
STEARNS MFG. CO.

Beginning on the 1st of May next, the Stearns Mfg. Co., of Erie, Pa., will establish a branch office in Chicago, which will be under the management of their Mr. A. F. Griswold, who has been with the firm for a great many years. Their office will be located in the Rookery Building, Room 1120.

THE DUPLEX ELECTRIC PUMP.

The accompanying illustration shows a combination ½ h. p. motor and pump in use for the past year at the Eureka mineral springs, Sagertown, Pa.

This little machine sits on a stone pedestal, about five feet high, in an open pavilion. It is run by a storage battery beneath the floor. The connecting wires being run through the pedestal, and the entire absence of spark gives it the appearance of a perpetual motion machine. When in operation it draws water from a depth of about 14 feet and throws one gallon per minute into a tank 150 feet away and 22 feet from the ground. The motor is wound for 110 volts and runs at a speed of 1,200 revolutions per minute, the armature shaft being geared to that of the pump in the ratio of 20 to 1. The entire floor space occupied is 16 x 18 inches.



The Duplex Electric Pump.

This combination was built by the Duplex Electric Co., Limited, of Corry, Pa., and like all of their motors and generators operates without rheostats.

THE EDISON BRANCH AT SPRINGFIELD, MASS.

An occasion of unsual enjoyment was that of a dinner given to members of the press and central station superintendents of Western Massachusetts and Eastern Connecticut by the Edison General Electric Co. at the opening of their new branch store at Springfield, Mass., on the evening of March 17. At an early hour a large number of invited guests assembled in the spacious and elegantly arranged store located at 219 Main street, and after having been shown the dynamos and motors in operation and having ample opportunity for looking over the large and complete stock and new fixtures, the entire company, under escort of Mr. Todd, the local manager, repaired to the private dining-room of the Cooley House. The table was prettily decorated with flowers. Groups of colored miniature incandescent lamps were hidden beneath the blossoms and leaves, and abundant light was afforded by the small lamps. After having leisurely discussed the several courses provided, various toasts were drunk, among which were those to the Edison General Electric Co., the Springfield store and the press. In reply to these several toasts, Mr. Kimball of the supply department of the New England district introduced Mr. Knight, the district auditor; Mr. Anderson of the Springfield Co.; Mr. Todd, manager of the new store; Mr. Smith representing the press, and Messrs. C. C. Pierce and S. A. Douglas representing respectively the street railway and the central station departments of the New England district.

These gentlemen replied in very happy vein to the various subjects to which they were called, and the remarks together with instrumental and vocal selections rendered during the evening kept the company at table until a late hour.

The opening of the new store which is the first of its kind in Springfield marks a decided advance in the business of the Edison General Electric Company. The sales of that corporation have steadily grown during the past until it became necessary in order to properly attend the wants of its numerous customers that districts should be organized , and now in order that the districts may still further cover the ground in a more satisfactory manner sub-stores are being established in some of the larger cities and towns throughout the jurisdiction of the various district managers. While the banquet of Thursday was very informal in its nature, it proved one of the most enjoyable occasions to which the gentlemen present had ever been invited, and in leaving, the heartiest and most unanimous expressions of satisfaction were tendered the representatives of the Edison Company for so satisfactorily providing for their guests and friends.

ENGINEERING EQUIPMENT CO.

The annual meeting of the stockholders of the Engineering Equipment Co. was held March 19, 1892, in the Hudson County Bank Building, Jersey City, N. J., and the following board of directors elected : Mr. C. A. Tinker, F. H. Underwood, A. L. Tinker, E. L. Harriot and F. A. Magee. Mr. A. L. Tinker was elected secretary and treasurer, and E. A. Magee, general manager. Mr. Magee will retain his position in Boston.

QUEEN & CO.'S ELECTRODYNAMOMETER.

Some time ago this enterprising firm placed on the market a new type of electrodynamometer which, we learn, has met with great favor. By the adoption of an agate bearing instead of fibre suspension as formerly used, the element of torsion is eliminated, and greater accuracy is obtained in consequence. These instruments are extensively employed as absolute standards in measuring both direct and alternating currents, and are especialy suited for use in central stations as checks for the ordinary commercial ammeters.

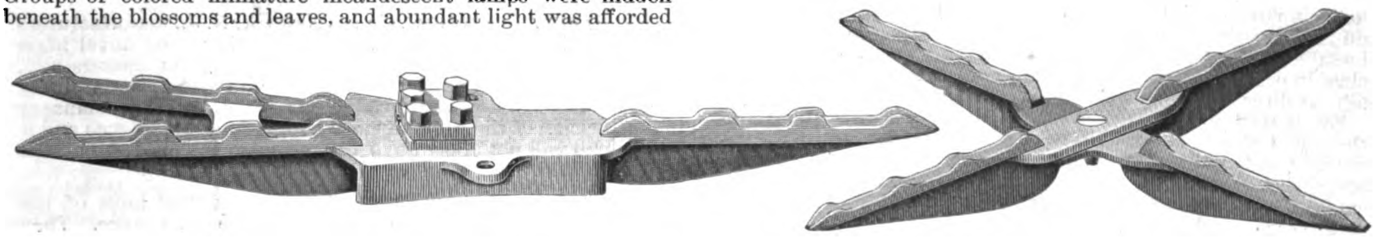
THE TORONTO INCANDESCENT ELECTRIC LIGHT CO.

The stock of the Toronto Incandescent Electric Light Co., Ltd., is selling on the Toronto Stock Exchange at 20 per cent. premium. This company commenced operations two years since, and now has a paid-up capital stock of $500,000. A 6 per cent. dividend has been paid since the start.

THOMSON-HOUSTON STANDARD PATENT SWITCHES AND CROSSINGS.

In the overhead wires of an electric street railway there must be a switch or frog to correspond to every switch or frog in the track. These overhead frogs must be as light as is consistent with the necessary strength, and they must be so constructed as to fulfil their purpose with certainty. The frogs manufactured by the Thomson-Houston Company are claimed to possess these qualities, besides being light and strong, easily put up, and certain in their operation. The forms shown in the accompanying illustration have been designed to meet all the conditions of line construction.

The standard frog, Fig. 1, made in the form of a **Y** is best suited to most requirements ; but frogs are also provided for right-hand and left-hand switches, and a three-way frog for double-branch switches. The trolley wire is soldered into the grooves between the clips on the tongues of the switch, and is also firmly clamped by the screws and metal cross-pieces on top of the frog plate. Provision is made at the sides for the attachment of cross suspension wires.



Figs. 1 and 2.—Thomson-Houston Standard Switch and Crossing.

Where two overhead wires cross each other a similar arrangement to the frog is used, with only slight changes necessary to adapt the apparatus to the different conditions met. Two forms of this apparatus are made, one of acute angle crossings, and the other for crossings at an approximate right angle. Both forms are made to swivel, so that the tongues will adjust themselves to the exact angle at which the wires cross.

NEW YORK NOTES.

Messrs. W. H. Gordon & Co., 115 Broadway, wish it distinctly understood that they have not gone out of the wire business. A recent notice in one of the trade papers mentioning the severance of one of their connections is calculated to create a wrong impression. They wish their friends to bear in mind that they have even greater facilities than heretofore for furnishing them any grade or kind of wire they may need. It should be borne in mind that on bare and insulated wire, line material, lamps and several other specialties, Messrs. W. H. Gordon & Co. are manufacturers' agents and are selling at factory prices.

The Norwich Insulated Wire Company have just closed a large contract with the United States Electric Light Company of Washington, D. C. This contract will aggregate about thirty miles of the above company's wire. Mr. F. Day Voorhees, general sales agent of this company, has just returned from quite an extensive trip throughout the West in the interests of his company, the result being the bagging of some very handsome orders.

The Dreher Manufacturing Co., manufacturers of high grade lubricating oils, will shortly remove to new and more desirable quarters at 249 Front street. This company is in receipt of some flattering testimonials regarding its specially refined oil for dynamos, etc. The trade with electrical concerns shows a wonderful growth in the last few months.

The Standard Paint Company are sending out a very neat catalogue and price list of their specialties. This little work is dedicated to the electrical fraternity particularly, and besides giving directions for the application of their well-known compounds, etc., it contains a number of congratulatory letters from those who have used these goods.

The Interior Conduit and Insulation Co., of 42 and 44 Broad street, have issued a "Cautionary Notice" to architects, builders, owners, etc., which defines their position as to interior wiring patents, and dwells at some length on the validity of their claims. It contains also copies of the injunctions recently obtained in New England.

The Short Electric Railway Company announce recent sales to the Braddock Electric Railway Co., Braddock, Pa.; the Union Passenger Railway Co., Chester, Pa.; The Fort Wayne Electric Railway Co., Fort Wayne, Ind.; the Schuylkill Electric Railway Co., Pottsville, Pa.

Mr. C. H. Davis, C. E., of 120 Broadway, has issued a neat little folder called "Facts and Figures" relating to matters of interest to all concerned in electric railroading. It is very meaty and valuable.

The Indurated Fibre Pipe Co. have removed from their old offices in the Central Building, and will hereafter be found in a very desirable suite of offices in the Aldrich Court, 45 Broadway.

Mr. Henry Alexander, the treasurer of Alexander, Barney & Chapin, has tendered his resignation and will sever his connection with the company April first.

PENNSYLVANIA NOTES.

The Harrisburg Foundry and Machine Co. are adding $30,000 worth of new machinery to their factory, and expect in a short time to increase their present large production. The Ide and Ideal engine built by them are meeting with the strongest recommendations for economy, strength, regulation and general efficiency. The company has recently sold a 400 h. p. cross-compound engine for the Post Engineering Co., of Boston, one 250 h. p. tandem compound engine for the Central Iron Works of Harrisburg, together with some 30 engines both compound and simple for New York, Philadelphia, Boston and electric companies throughout the United States. The company are also doing a large business in boilers, and have just sold ten 100 h. p. return tubular boilers with Westmeyer furnaces for the Central Iron Works, of Harrisburg; six 100 h. p. return tubular boilers for the Paxton Rolling Mills, Harrisburg; two 100 h. p. return tubular boilers with Westmeyer furnaces for the Morrison & Carr Paper Co., of Tyrone; also numerous other boilers ranging in size from 40 h. p. to 80.

The Eureka Tempered Copper Co., of North East, Pa., are running to their full capacity, and are compelled to work night and day to meet the growing demand for their specialties. They report large orders, and have orders booked from one firm alone for over fifty thousand commutator bars. They have made arrangements with O. Berend & Co., 61 Fore street, London, E. C., to handle their goods exclusively in the United Kingdom. They have also established an office in Vienna, and are already doing a large business in Europe.

Mr. Otis K. Stuart has accepted the agency for the Duplex Electric Co., of Corry, Pa., who manufacture the Duplex motors, dynamos and arc lamps.

Partrick & Carter Co. announce that the Disque battery has many points of superiority that have given it a well-earned reputation for reliability. Improvements have been lately added which greatly increase its efficiency and cleanliness. The lead top connection and covered cell are new features that will recommend themselves to every purchaser and user of open circuit batteries. The new form is shown in the firm's advertisement this week.

The East Harrisburg Passenger Railway Co. are about to duplicate their present plant and will add several miles of track, new cars and 450 h. p. Wetherell cross-compound condensing engine. This company are using the Groetzinger "Dermaglutine" pinions on their motors. One of these shown your representative had run over 57,000 miles and is still in use.

WESTERN NOTES.

Electric Merchandise Co.—A fair index of the great amount of business in sight in the electric railway line can be found at the office of the Electric Merchandise Co., Chicago. As the company confines its business strictly to electric railway supplies, it is perfectly natural for street railway men to call and examine the standard appliances handled by it. In fact, No. 11 Adams street has become general headquarters for all interested in street railway matters. The prompt and careful attention given to orders is appreciated by the managers of street roads, and accounts to a great extent for the popularity of the company. Owing to largely increased facilities, the company is better fitted than ever to meet the growing demands of the trade.

The Electric Appliance Company have been mailing a circular containing a description of the "swinging ball lightning arrester," with a few of the numerous testimonials received, to the Western trade. They report that judging from the number of replies received from persons familiar with the merit of the device and who state that they will use a large number of them this spring, they are sure of orders that will test the capacity of the factory.

The Central Electric Company report the sale of three underground cables of the Okonite manufacture within the past week. From the many proposals that are out, they expect to be busy in this department very shortly. They are preparing to put on the market an absolutely dust-proof bell, one that will be perfect in every respect.

NEW JERSEY NOTES.

The Suburban Electric Co., Elizabeth, N. J., organized last December with $350,000 paid up capital, and consolidating all the electrical interests of Elizabeth and Roselle, are building a new station at the foot of Murray street beside the Elizabeth River. The building, designed by Mr. E. P. Ball, of Palmer, Mass., will be 87 x 225 feet, of two and three stories of the most approved modern type, with engines capable of being run either condensing or non-condensing. The plant and most of the apparatus is intended for double the capacity at present required. Three compound condensing engines of Corliss type will be used, taking their steam from vertical fire-tube boilers. The station capacity at the start will be for 200 arc lamps, 8,250 incandescent, and 80 h. p. of motors; furnished by Thomson-Houston, Edison and Westinghouse dynamos. More generators will, however, be needed soon, and in all about 225 miles of feed wire will be used. The Edison mains are for the most part underground. The directors hope to have the plant in operation by May.

The Safety Electrical Co., of Newark, N. J., manufacturers of general electrical specialties, are introducing some novel ideas in the construction of their new bells, annunciators, buzzers, etc., for which they claim particular excellence in principle, simplicity of construction and workmanship. Mr. R. J. Britton, manager and electrician of the company, has had years of experience and is a man who will not allow anything put upon the market but the best in his line.

Jersey City.—The patronage of the new power lines of the Jersey City Electric Light Co. is getting to be very large. They have have among other motors recently placed a 60 h. p. motor in the F. O. Matthiesen flour mills. The company has had much trouble with the quality of water supplied, but are at present using a Hopping waste water purifier with success.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

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A DIRECT CURRENT TRANSFORMER PLANT AT OLYMPIA, WASH.

BY

R. Fleming

LIKE a great many other Western towns, Olympia, the capital of the new State of Washington, rejoices in the possession of an adjacent waterfall, which, thanks to the enterprise of Mr. E. T. Young and his associates, of the Olympia Light and Power Co., is being utilized to furnish light and power to the city and its inhabitants. The waterfall is two miles distant on the De Schutes River, which, after a rugged and picturesque journey from its source in the great glaciers of Mount Tacoma, drops abruptly eighty feet into the placid waters of Puget Sound.

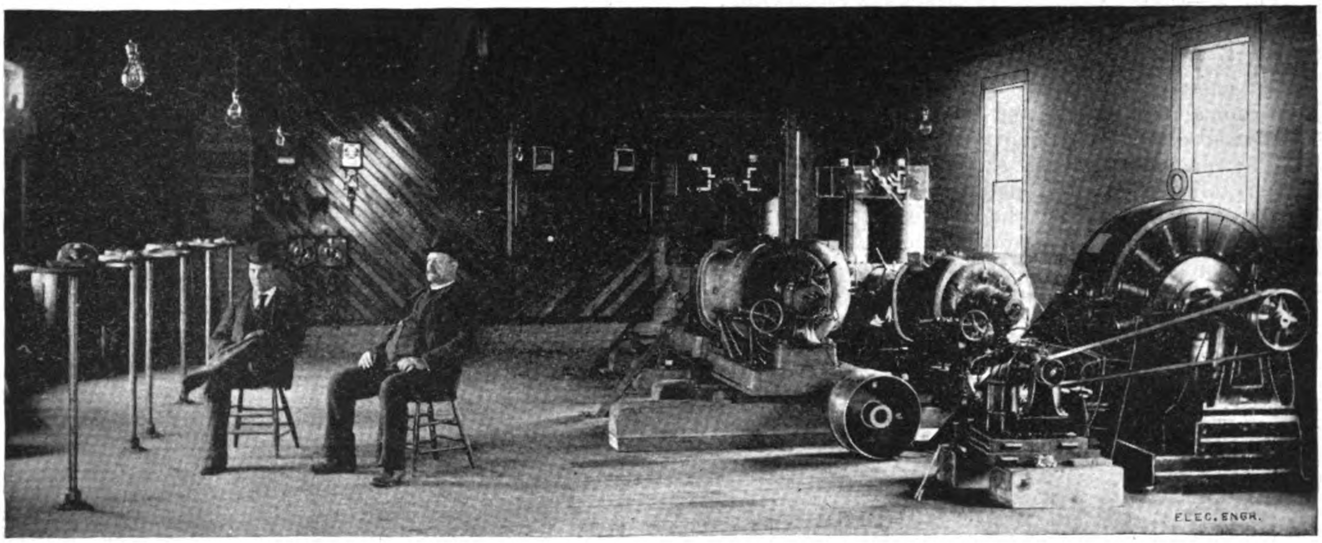


FIG. 1.—POWER HOUSE OF THE OLYMPIA LIGHT AND POWER CO., OLYMPIA, WASH.

The company furnish arc and incandescent lighting, and are now preparing to build several miles of street railway to connect Olympia with the neighboring town of Tumwater. The arc machines in use are of the new Edison type; these have now been running nearly a year, and are giving excellent service.

Both alternating and direct current transformer systems are employed. Though the latter system has been repeatedly set down as impracticable, it is here doing all that could be desired, and is both practical and efficient; the sole objection to it being that of requiring attendance at the sub-station. This item is, in a small plant, of course, objectionable.

The arrangement is as follows: Two 60 K. W. Edison 500-volt generators are placed at the power house, shown in Fig. 1, and are so arranged that by throwing a switch they can be grouped in multiple, or in series, as desired, and a two or three wire system can be used, the ground acting as the neutral conductor. Power for running the sub-station is taken from the "outside" wires at a pressure of 1,000 volts. Ordinary motors are connected between either outside wire and the ground. The distance from the power station to the sub-station is over two miles.

The transformer plant at the sub-station, Fig. 2, consists of one 80 K. W. motor, Edison type, driving by means of belts in tandem two smaller compound-wound dynamos of the standard incandescent type. These supply current to the network of wires on the lines on the usual three-wire system.

Though this arrangement seems complicated, and to require considerable machinery, yet the results obtained are all that could be desired both in point of efficiency and regulation and will compare favorably with any other system of transformation. The regulation is far better than can be obtained with alternating converters. This plant has been running now for almost a year without a hitch, even though the output has been at times far above the overload limit. The object of the company in adopting this system was to enable them to obtain power for motors and lighting purposes from the same generators. For lighting purposes alone, this arrangement could have been simplified considerably by using one generator instead of two, and increasing the voltage.

Some months ago the gas and electric company and the above-named company consolidated, using the name of the Olympia Light and Power Company. The gas company's plant consisted of one fifty-light Thomson-Houston arc dynamo, and one 1,300-light alternator of the same make. The latter was transferred to the water-power sta-station, while the arc machine, together with a 75 h. p. Russell engine, was held as a reserve at the old station, arrangements being made to connect this machine with either arc line at will.

The water wheel plant from which power is derived consists of two pairs of 15-inch Victor horizontal wheels, both connected to the same shaft, on which are mounted six friction clutch pulleys and two heavy balance wheels. Wheels and clutches are controlled from the dynamo floor above by means of upright shafts and hand wheels. All the hydraulic machinery, including wheels, shafting, etc., and flumes, was built by the Stilwell & Bierce Manufacturing Company, of Dayton, Ohio. All the electrical construction was done by the writer for the Edison General Electric Co., Pacific Northwest District.

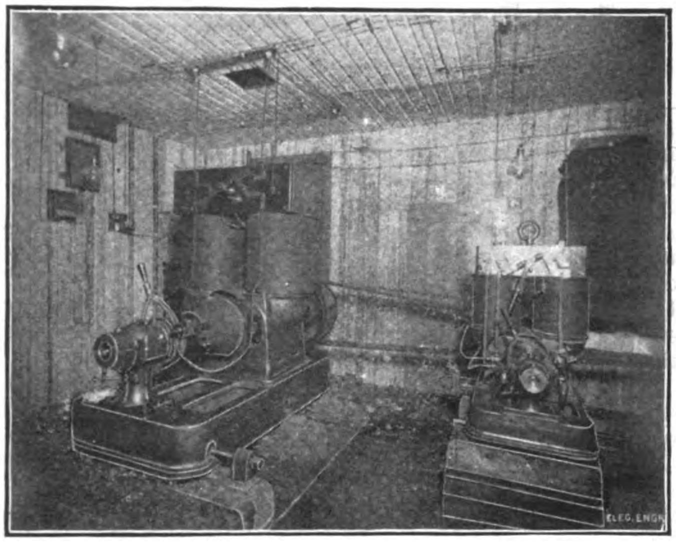


FIG. 2.—DIRECT CURRENT TRANSFORMER SUBSTATION, OLYMPIA, WASH.

A NEW METHOD OF DUPLEX TELEGRAPHY.

BY

Jno. J. Ghegan

ALTHOUGH the ordinary systems of duplex telegraphy are generally said to double the capacity of a line it must be admitted that they have been up to the present incapable of doing it. They are only capable of sending two messages at the same time, in opposite directions and between terminal stations, and "breaks" can only be made by interrupting the opposite side.

To actually double the capacity of a wire, two complete and independent circuits should be so formed that intermediate offices can be on either or both of them, and so that any office on the line can send two messages in the opposite direction or in the same direction at the same time, thus constituting both a duplex and a diplex. The writer undertook to devise such a system, and actual tests have demonstrated the possibility of filling all the requirements mentioned above.

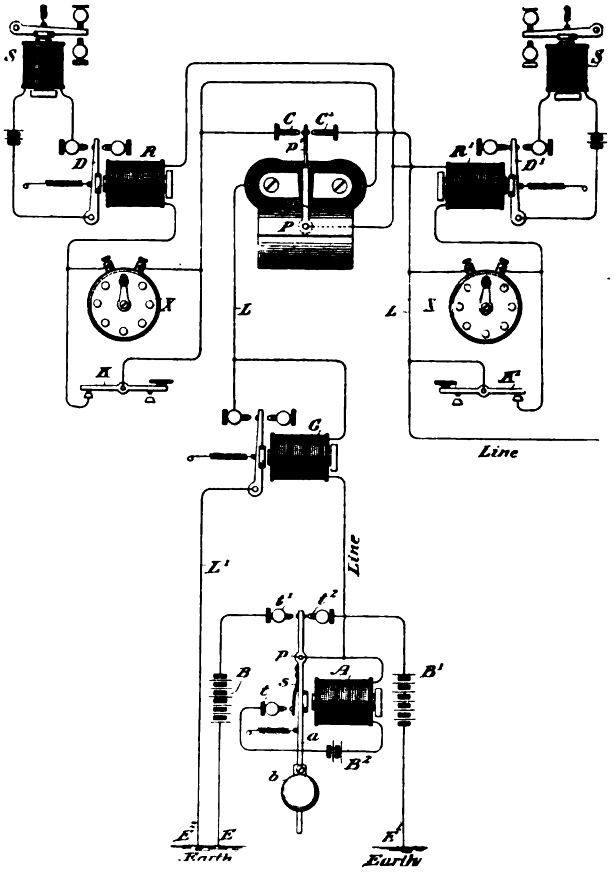
The only changes required to make the ordinary instruments available for this system is to reverse the contact points of the keys and relays, and even these changes can be dispensed with under a slightly different arrangement. The stations would, however, have to be provided with rheostats and polarized relays in addition to their ordinary instruments.

But one main battery is required and that can be located at any station on the line. The battery station is also provided with an automatic pole changer, which sends rapidly alternating pulsations to the line. These pulsations are separated at each office so that the positive pulsations pass through and actuate one set of instruments and the negative pulsations actuate the other set.

The signals are transmitted by varying the resistance of the line for the pulsations of either polarity without interfering with its normal resistance to pulsations of the opposite polarity.

This will be better understood by reference to the accompanying diagram which represents the arrangement of a station with main battery at one end of the line. The upper portion shows the arrangement of the apparatus at all the other stations having instruments on both sides of the duplexed line. Two main batteries are shown in the lower part of the drawing, but with proper connections to the pole changer one is sufficient, or an alternating dynamo may be substituted for the battery and pole changer.

It will be noticed that between the pole changer and the line a relay G is placed and that the line, after passing through this relay is in connection with its back-stop, and that the relay armature is connected to the earth. This earth contact through the back-stop of the relay is employed to discharge the line after each pulsation. Each station is provided with a polar relay P, neutral relays R R', keys K K', local sounders S S', and resistance boxes X X', arranged as shown, the resistances being located in shunt around the keys K K'.



THE GHEGAN DUPLEX TELEGRAPH SYSTEM.

The operation of the system is as follows: The armature of the polarized relay P vibrates between the stops C C' at each change of polarity due to the action of the pole changer and batteries at the battery station; the neutral relays R R', and the rheostats X X′ are also in circuit with the polar relay P. It will be noticed that the armature and contact points C C′ of the polarized relay P are so connected that they shunt or cut out one or the other of the neutral relays R or R′ with its corresponding rheostat and key K or K′, according to which of the points, C or C′, is in contact with said armature. Therefore as the armature of the polarized relay responds to the changes of polarity of the pulsations sent to the line, it alternately shunts or cuts out the neutral relay R or R′ so that one of them is influenced by the positive and the other by the negative pulsations only, and consequently any variation in tension or current strength of the positive pulsations will only affect the corresponding neutral relay, and vice versa.

These neutral relays R R′ are so adjusted that by throwing in circuit a suitable resistance X or X′ the tension or current strength is so varied that their armatures fail to respond to the weakened pulsations and are drawn against their back-stops. The resistance thrown in need not be sufficient to prevent the armature of the polarized relay P from responding. The resistance being only in circuit while its corresponding set of relays are also in circuit, it consequently does not affect the relays which correspond to the opposite pulsations.

Depressing a key interrupts the low resistance path of the circuit around a rheostat and thereby changes the current tension at each recurring impulse of the corresponding polarity, so that the armatures of the neutral relays which are in circuit for the weakened impulses remain on their back-stops, and close their local circuits as long as the key is head down.

Thus it will be seen that all the sounders S will receive signals by the varying of impulses of one polarity, while sounders S′ will receive signals by varying the impulses of the reverse polarity on actuating the keys K K′, respectively. It is obvious that with this system each side of the duplexed line is independent of the other; that way, or intermediate, as well as terminal, offices can be on either or both sides, and that two messages can be sent at will in the same, or in opposites, directions at the same time.

MEASUREMENTS OF THE HYSTERETIC LOSS OF MAGNETIC ENERGY IN NICKEL.

BY

A. E. Kennelly

THE energy absorbed in hysteresis by substances under reversals of magnetization is probably measured most conveniently by the use of a wattmeter with an alternating current. This method cannot be employed when the Ewing *H B* diagram, or the relation of flux to field, is required, but where only the integrated area of that diagram or the hysteretic energy per cycle is needed for definitely varying maximum flux densities, the convenience, swiftness, and precision with which the observations can be carried out give it great advantages.

Measurement was made of the hysteretic loss of energy in two samples of good commercial nickel wire, each wound up in a coil or Faraday ring. The connections are shown in the Fig. 1. P and S are the primary and secondary coils of a transformer operated by an alternator with an average and nearly uniform frequency of 141.6 ~. The regulation of the alternator fields controlled the E. M. F. in the coil S, whose circuit was closed through the ammeter A, the fixed coil of a dynamometer wattmeter D, and the insulated winding of the nickel wire ring R. The suspended coil *c* of the dynamometer was permanently connected through an adjustable resistance *r* across the terminals 1 and 2 of this ring. Before and after each wattmeter observation, the Weston alternating current voltmeter V was also connected to the terminals 1 and 2, and a reading of the pressure taken.

The dynamometer was a nearly dead-beat, unifilar torsion instrument, read off by telescope, mirror and scale, Its suspended coil having eight ohms and three millihenrys, in circuit with the resistance *r* of from 1,000 to 6,000 ohms according to the pressure, it is evident that the error in the readings due to lag in the suspension circuit was negligible. The instrument was also sensitive, and gave about 20 degrees of twist per watt of indicated power.

It is worthy of remark that the use of such alternating current wattmeters has been often avoided on the ground of inductance error, but when made with sufficient sensitiveness to need only small inductance with high resistance in the suspension circuit, the charge is unfounded, and their indications in power measurements become reliable. For if *c* be the current passing through the fixed coil, and *s* that in the suspension, under an effective pressure *e* through a large resistance *r*, with a total inductance *l*, the maximum error in watts that *l* can effect in the readings with a pulsation $p = 2 \pi n$ is,

$$r\, s\, c \sin \tan^{-1} \frac{pl}{r}, \;\ldots\ldots\; \text{or very nearly} \;\ldots\ldots\; e\, c\, \frac{pl}{r}.$$

In other words, the maximum error would be the apparent watts or product of volts and amperes multiplied by $\frac{pl}{r}$, while the actual error is generally much below this limit.

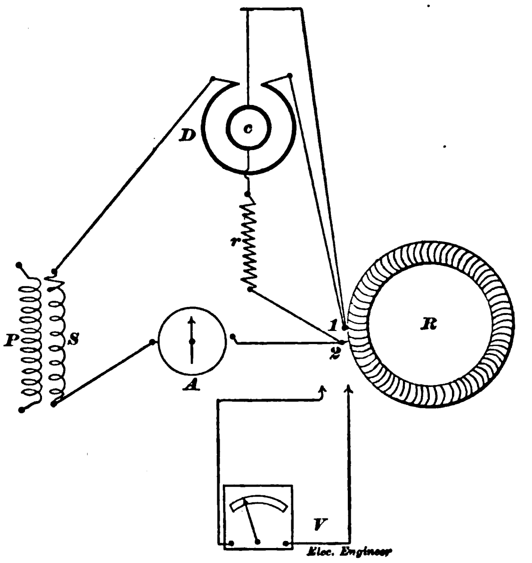


FIG. 1.

The particulars of the rings are given in the following table. The weight of nickel in each was the same, but the diameters of the nickel wires were different. The winding of insulated copper wire was also the same on each:

	Coarse wire ring.	Fine wire ring.
Turns of wire,	570	between 4,000 and 5,000
Diameter of wire,	0.0365″ 0.0927 cm.	0.0126″ 0.032 cm.
Sectional area of wire,	0.006749 sq. cm.	0.000804 sq. cm.
Weight of wire in ring,	2,255 gms.	2,255 gms.
Volume of wire in ring,	253.3 c. c.	253.3 c. c.
	Cross-section of ring.	
By number of wires,	3.848 sq. cms.	
By external dimensions,	3.852 "	3.852
Mean diameter of ring,	20.93 "	20.93 cms.

Winding..... ....700 turns of copper wire on each ring.
Resistance of winding at 18° C..................2.815 ohms.

Before applying the copper wire winding to these rings, they were well soaked in melted paraffine wax, with the object of limiting all eddy currents as much as possible, although previous tests on the rings without this precaution do not by comparison show appreciable loss from eddies when the bare nickel wire was used. Some 200 grammes of paraffine wax was absorbed into the rings.

In reducing the measurements, the wattmeter readings were corrected for the extra incidental losses of power, namely, $\frac{e^2}{r}$ in the suspension circuit, and $c^2 R$ in the ring. The balance gave the loss in hysteresis assuming no loss in eddies. The voltmeter pressures at ring terminals reduced by $c R$ gave the counter E. M. F. of the ring, from which the maximum flux density in the nickel was determined on the assumption of a simple harmonic E. M. F.

The accompanying curves show the resulting ranges of hysteretic loss per c. c. of nickel for the two rings at varying flux densities. The loss is nearly 25 per cent. greater in the coarse wire. The curves agree very fairly, however, with the law of $\frac{8}{5}$ exponent, as lately enunciated by Mr. Steinmetz[1] for iron, the dotted lines representing the locus of this exponent drawn from the datum point for $B = 1,500$ on each curve. The hysteretic loss in ergs per c. c. per cycle for the coarse wire is thus apparently 0.00125 $B^{\frac{8}{5}}$ for the coarse wire, and 0.00101 B for the fine, between the limits of 0 and 3,000 of maximum cyclic flux density.

There are two reasons for believing that this difference between the absolute values of the hysteretic loss in the two rings was not due to eddy current influence; 1st, that, as above mentioned, the loss of energy was not found to increase when no paraffine was used to insulate the wires; and 2d, that eddy current influence would introduce a term varying as B^2, and the resulting curve would diverge from a curve of $B^{\frac{8}{5}}$.

The hysteresis was quite definite in each ring, and any reading could be reproduced at will, by adjusting to the right pressure at the voltmeter. Eight series of measurements were made in this way at different times, four series on each ring. The results seem to show that, approximately at least, the hysteresis in nickel varies, as in iron, with the $\frac{8}{5}$ power of the maximum flux density, although the difference in the coefficient would indicate some latitude in the amount of hysteretic dissipation with different specimens. As with iron therefore, doubling the flux density in nickel, practically trebles the hysteretic loss.

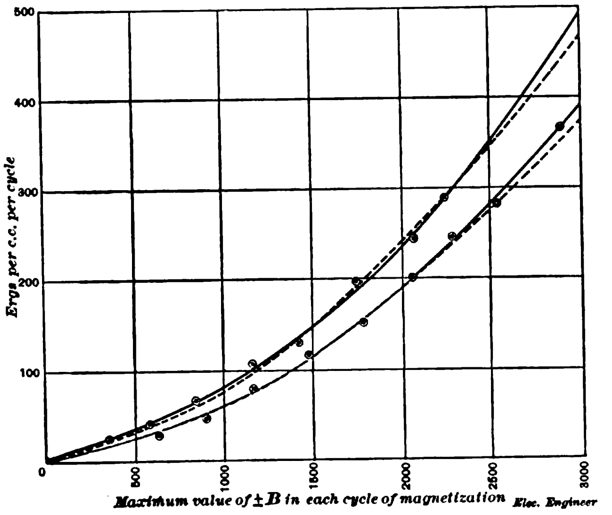


FIG. 2.

The writer is indebted to Mr. A. Hoopes for assistance in carrying out this measurement at Mr. Thomas A. Edison's laboratory.

MR. TESLA'S EXPERIMENTS.

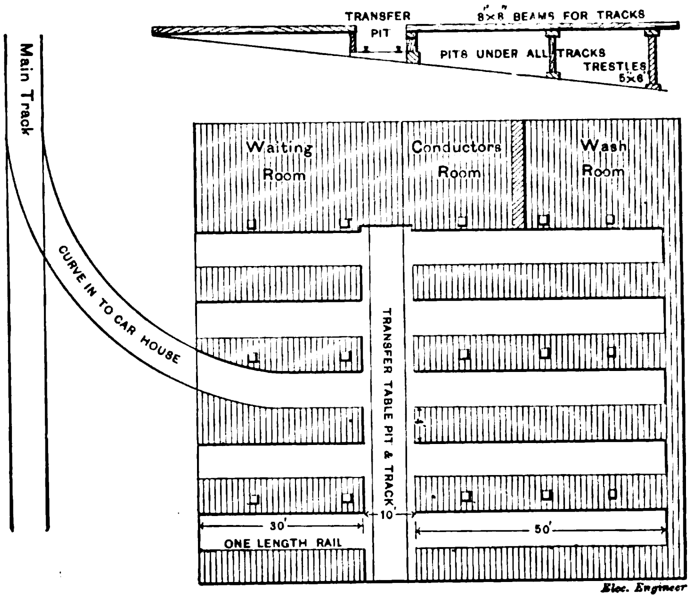
"THE French papers this week are full," says the *London Electrical Engineer*, "of Mr. Tesla and his brilliant experiments. No man in our age has achieved such a universal scientific reputation in a single stride as this gifted young electrical engineer."

ELECTRIC CAR HOUSES.

BY

A. K. McCay.

A GREAT deal of electric railroad construction is now being contemplated, and a few practical points as to car houses and their appointments may be in order. Of course, the shape and size of the lot will frequently decide the size and shape of the car house, but the architect who designs the same rarely has practical experience in aiding him in the work. To arrive at practical results and figures I will describe a car house designed and built by myself during the past year which has proved eminently satisfactory. The plot of ground was 150 x 100 feet, the 150 feet facing the main line. This plot was situated at the extreme end of the line.



FIGS. 1 AND 2.—ELECTRIC CAR HOUSE.

Fig. 1 shows the ground plan of tracks, giving the position of transfer pit and rooms; 60 x 100 feet deep was decided as ground to erect the car house upon. A curve was thrown into the centre of this 60-foot plot, and the tracks placed as shown. The ground on which this car house was built sloped gradually away from the street, being 9 feet lower at the rear than at the street. I decided to trestle all tracks from the transfer pit back. This arrangement, shown in Fig. 2, gave free and full access to every portion of the bottom of the cars and allowed plenty of room for removing gears, etc. Four feet was left between each set of tracks and only five sets of tracks were laid. These were laid on trestles, which were built of 5 x 6 inch hemlock, pinned together as shown in Fig. 2A. On the top of

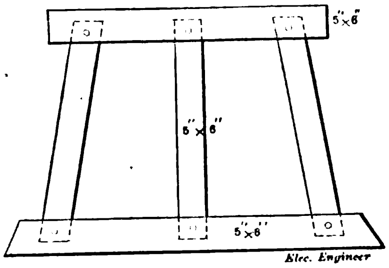


FIG. 2A.—ELECTRIC CAR HOUSE TRESTLE.

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[1] "On the Law of Hysteresis." A paper by Mr. C. P. Steinmetz read before the American Institute of Electrical Engineers, Jan. 19, 1892.

these were placed an 8 x 8 inch beam, on which was spiked the rail. The space between the sets of tracks was floored over, and cross-overs were placed between tracks at convenient intervals.

The space of 37½ feet was left between the front wall and centre of transfer-table pit. This allowed a single length of rail to be placed on each of the other tracks and one car kept on these, without any cutting of rails. These five tracks accommodate some 15 16-foot cars, with room for three more if desirable, when the waiting-room, conductors' room and washroom will have to be removed for the sixth track.

The workroom was equipped with a lathe and all necessary tools. The conductors' room was furnished with two beds, so that I could always have men present at the car house at all hours of the night. This convenience was appreciated several times when a heavy snowstorm came up and steps had to be taken to clear the track.

The height of this lower room for the cars was 20 feet; this allowed the trolley poles to go well up at night, and prevented a continual strain on the springs. The car house was well lighted, having thirty windows, 8 x 3 feet, distributed around the entire four sides. A well-lighted car house is essential to good work on the cars, and too much attention cannot be given to this point.

I decided to build my own transfer table, shown in Figs. 3 and 4, and for that purpose took three pairs of old street car wheels and axles, and built up on their boxes a heavy flat car. The wood used was maple, and was thoroughly bolted together, as shown in the sketch. The springs were taken out of the boxes, and heavy blocks of hard wood were wedged in above the axle. This gave the car rigidity and did not allow it to drop when the weight was placed on it. Beneath the three boxes on each side was bolted, as shown, a flat iron bar, 2 inches wide and ½ inch thick, which assisted the heavy beam above the boxes in preventing a racking motion. Heavy 2-inch boards were nailed on top of the longitudinal beams in two layers. Then the tracks were spiked down. The whole cost of the car, exclusive of wheels, was about $26, and it has been a marked success.

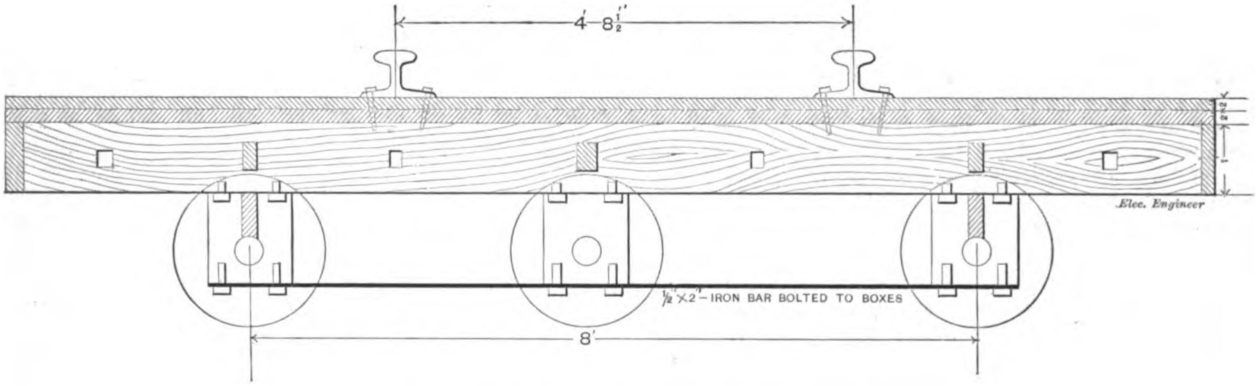


FIG. 3.—TRANSFER TABLE FOR ELECTRIC STREET CARS.

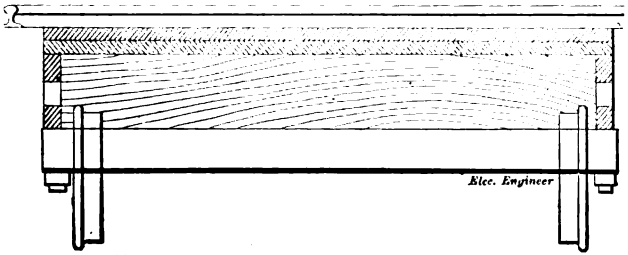


FIG. 4.—END VIEW OF TRANSFER TABLE.

The three sets of wheels per side made the table very easy to move, even when having a heavy vestibule car on it, and a simple lever-locking device, arranged to be worked from the side of the table was used to hold the car in place. The table was always kept opposite the middle track, so that a car coming in from the main track could not plunge into the pit. This transfer pit was used quite often when plenty of room at the end of a car was desirable, the car being allowed to project over the transfer pit. This was found to be very handy and will be appreciated by any one who has had to take off the axle-gear in a cramped pit.

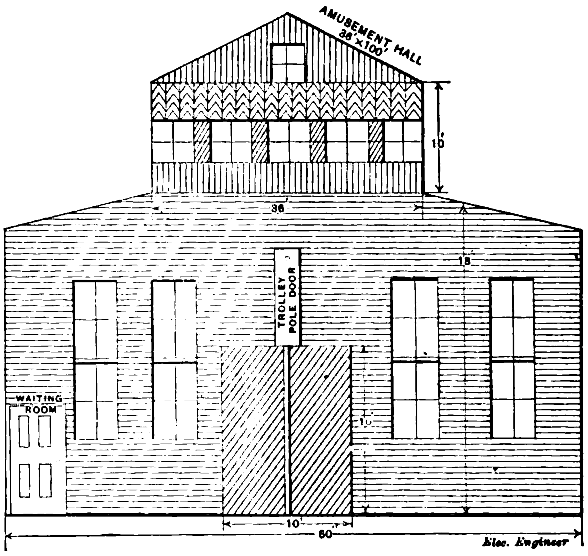


FIG. 5.—ELECTRIC CAR HOUSE.—FRONT ELEVATION.

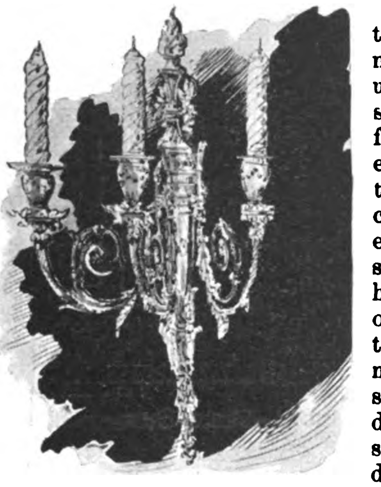
As stated above, the car house lot was at the extreme end of the track; this fact led to the adding of a second story to a portion of the car house for an amusement hall, access thereto being gained by a stairway from the waiting-room. This proved to be very valuable for concerts, entertainments, fairs, etc., completely repaying for the additional expense necessary to build it. And I should strongly advise any company building a car house at the end of the line, or at some distance from the centre of the city, to lay out the additional money; it will pay, and pay well.

These are the salient features of this particular car house. Since building it I have visited many others, and while I have seen the same principles differently embodied, I have seen none in which repairs and cleaning could be done so easily and so readily. The house was built of wood, finished inside with Georgia pine, the total cost being less than $4,000. On account of being built of wood, a standpipe, 4 inches in diameter, was run in from the street mains and carried up to the second story; this was provided with 100 feet of fire hose. This precaution, together with the fact that there were men in the building at all hours, materially lessened the cost of insurance. Fig. 5 shows a front elevation of the car house.

THE STATUS OF LIGHTING COMPANIES IN MASSACHUSETTS.[1]

BY

Franklin Leonard Pope



THE annual report of the Massachusetts commissioners contains, as usual, a vast amount of statistical and other useful information, in reference to the operations of the local illuminating companies for the year ending June 30, 1891. It still remains true, as I have heretofore had occasion to point out, that the manner in which this matter has been presented leaves much to be desired, inasmuch as a small amount of additional labor might have added greatly to the usefulness of the work, considered as a whole. For example, if one wishes to ascertain the aggregate number of dynamos, or motors, or incandescent, or arc lamps in use in the State, he must resort to the laborious operation of footing up the figures as separately reported by each company, which ought of course to have been aggregated, once for all, by the compiler of the report.

The returns made by the several companies are tabulated in accordance with a schedule of instructions issued by the board in 1887. In returning the "cost of works" the instructions provide that "this account should show, either in detail *or in one construction account* the cost of the company's works, including real estate, steam plant, electric plant, meters, lines, lamps and globes." It results from the alternative direction which we have italicized, that there is considerable diversity in the way these accounts have been made up, a circumstance which is particularly annoying to the comparative statistician. It would be altogether preferable if the separate items of the construction account were required to be reported separately and in detail by all the companies, as they now are voluntarily by many of them. It would moreover be an excellent idea if the various State boards, and the National Electric Light Association could agree upon a uniform schedule for reports of this character, to be made by all the companies in the country.

Not only is there no increase in the number of electric light companies operating in the State since last year but owing to consolidations there appears to be a net decrease of two. It is quite clear, from a study of the returns, and of the profit and loss accounts (published for the first time last year), that there is not likely to be any material increase, from this on, in the number of electric light companies operating in the state. Electric lighting has apparently been introduced into every town and village in the state in which there was any chance of a profitable business, and indeed the balance sheets show that in a considerable number, especially of the smaller towns, the expectations of the promoters of these enterprises have by no means been realized. Such of the companies as have succeeded in establishing a paying business, are nevertheless enlarging their field of operations as rapidly as possible, so that the industry as a whole may be said to show a very gratifying progress.

In 1887 the legislature of Massachusetts passed an act authorizing such gas companies as should first have obtained the consent of the Commissioners, to furnish electric light. From the present report, it appears that up to June 30, 1891, of the 70 chartered gas companies in operation in the State, 26 had undertaken to furnish electric light also. A subsequent act was passed in 1891, authorizing cities and towns to manufacture and distribute gas and electricity. It appears from the report that of the 210 towns and cities in the State having a population of 1,500 or more, 180 have taken no action in the matter. In most of the places in which action has been taken the voters—as I think, wisely—decided not to embark in the business. Danvers appears to be the only municipality, thus far, which has an electric plant in actual operation, and this is merely for street and not commercial lighting. The whole number of municipalities maintaining public electric lights is 79. Of these, five use the incandescent light, 74 the arc, and 41 use both. The total number of commercial incandescent lamps reported is 161,259, as against 118,529 the preceding year, an increase of nearly 37 per cent., which is a very good showing. Twenty-five companies have paid dividends this year as against 22 the preceding year. The total of dividends paid foots up $262,958, as against $154,708 the preceding year, an increase of 78 per cent. These figures show clearly that the financial situation of the well-established plants is improving rapidly with the increase in their business.

The effect of the competition of the electric light on the sales of gas by meter is observable principally in the check which it has given to the normal rate of increase which would otherwise have taken place in gas consumption. The gas receipts for sales by meter show a net increase over last year of about $8,000; but, on the other hand, the receipts from public lamps have fallen off no less than $35,000 during the same period.

The list of casualties shows only five persons injured during the year by electricity, one of which cases resulted in death. This was an accident resulting from a contact between the primary and secondary wires of a transformer, a possibility which is now most carefully guarded against in the most approved forms of apparatus of this kind.

INSULATED ELECTRIC CONDUCTORS.[1]—IV.

BY

James Brainerd Williams M.D.

CHAPTER III. (*Concluded.*)

LET us next test a wire insulated with a vulcanized rubber compound. We find upon charging it and then touching the insulated layer with the finger that the spot of light suddenly drops four or five divisions, perhaps vibrates a little, and then comes to rest. We place a second, and then a third, finger upon the dielectric and obtain further "drops," but no leakage, the spot of light, after the second and third drops and their accompanying vibrations remaining stationary. These drops are caused by the absorption of small portions of the charge by those portions of the dielectric between the fingers and the wire, and *not* by any leakage. They vary with the extent of surface touched by the bodies connected with the earth—in other words, with the capacities of the condensers thus formed—and with the specific inductive capacity of the material of the dielectric. As the preliminary tests have shown us that this wire is well insulated, we will test it further, and obtain results which are recorded for future reference when comparing this wire with others of the same diameter and length, having the same thickness and length of insulating layer or dielectric. We take eight inches of the wire and trim and paraffine the ends of the dielectric to prevent surface leakage. A strip of smooth tinfoil (the writer generally uses a wet rag) is closely wrapped upon (say) four inches of the dielectric. This converts the four inches of the sample into a condenser, and what we now want to ascertain is the *rate* at which this condenser discharges itself. Lay the sample thus prepared in the **U**-shaped supports, connect it with the electrode of the quadrants, and hang the hook H, upon the tinfoil. Then fasten a *tested* ground wire in the binding screw of the lever K, and depress K until it is held against the bottom contact of the key by the trigger.

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[1] Seventh Annual Report of the Board of Gas and Electric Light Commissioners of the Commonwealth of Massachusetts. (Pub. Doc. No. 35.) Boston, 1892.

[1] *Copyrighted* 1891, *by James B. Williams, M. D. All rights reserved.*

The quadrants are now fully charged, and we wait until the image rests at 300. A watch is held in one hand and at a given time the finger knob of the trigger is strongly depressed and the lever, K, being thus released, flies past "Insulate" to the top contact of the key. Connection is thus established between the outer coating of the condenser (the tinfoil) and the earth by means of the hook, flexible conductor between the hook and top contact, lever, and ground wire, G, one branch of which is fastened to the binding screw on the rear pillar of the key. The instant the lever strikes against the top contact the spot of light always makes a sudden drop, but its subsequent movements depend upon the specific resistance of the insulating material. If this resistance be high the image will settle upon 290 (say) and remain there. If the resistance be lower than in the last instance the image instead of settling upon 290 (say) will "hesitate" upon it, as it were, for an instant, and then pass slowly down the scale. If the resistance be still lower the image will drop at first, then its speed will become less; but there will be no checking of the speed after this, and the image will move steadily down the scale, but considerably faster than in the second instance. In the second instance we note the time occupied by the image in moving from 290 to 100, for instance; and in the third the time occupied in falling from 300 to zero, for instance. The information we have obtained is written on a tag, with the date of testing, and the tag secured to the sample.

If this sample be tested at the same potential six months afterward we will obtain the same results provided—

1. The normal position of the needle and, consequently, the zero position of the image on the scale have not been changed during the interval. We could not be certain that these changes had *not* occurred if the needle system were suspended by a single fibre and its movements controlled by means of permanent magnets.

2. Dust or moisture, or both, have not been deposited upon the exposed surfaces of the insulating layer, including the paraffine on the ends.

3. The insulating material has undergone no change.

4. The insulation of the apparatus is perfect then, as now.

5. The electrometer, scale, lamp, screen, and lens occupy the same position relative to each other during both tests. Even if removed, the electrometer and scale can always be replaced in the same positions by the aid of the "hole-slot-and-plane" arrangement.

We can always ascertain the time required for the image to fall from 300 to 150, while testing any *well* insulated sample, no matter what the first drop may be or how far the image has passed down the scale after the lever strikes against, and while it remains in contact with, the top contact of the key. This is done by raising the potential of the quadrants while the leakage is going on, by sparks from the coil, until the image is brought back to 300. To prevent the dielectric from being pierced by the sparks during this or any other process of charging, an adjustable device is previously placed between the electrodes of the quadrants which regulates the length of the sparks.

There are other methods by which samples can be tested by the electrometer when charged to high potentials, but those already explained must suffice. If we subject insulated wires now manufactured—omitting those termed "weatherproof"—to potentials of about 3,000 volts, and test them with the electrometer, we find a wide difference in the insulation resistance of their dielectrics. Some will leak rapidly if but four-inch lengths are tested; others will show very little leakage in 12-inch lengths; and others are so highly insulated that several feet must be tested in order to obtain any appreciable leakage. To further illustrate the uses of the apparatus, we fasten a fine wire in the groove of a glass or porcelain insulator, mount it on the pillar on the base of the key—the horizontal arm being removed from the pillar—and connect the fine wire with the electrometer, and charge to about 5,000 volts. We find upon touching *any* portion of the insulator with the finger, and sometimes with the point of a pin, that the charge rapidly escapes. If we carefully clean and dry the insulators *immediately* before testing they will not leak. For further information on this subject the reader is referred to an article by the present writer, on Porcelain and Glass Insulators in THE ELECTRICAL ENGINEER of February 17, 1892.

Leakage at the ends of lead-encased cables, when certain kinds of insulating material are used for the dielectrics, is a subject which deserves more attention than it usually receives. In some cases, marked leakage will occur in a few minutes, if the newly cut ends of such cables are exposed to dampness. This subject will be treated of in an article on the protection of insulated electric conductors.

There are many experiments which can be beautifully illustrated by means of this testing apparatus, such as the variations of the capacity of very small condensers, and the phenomena of the residual charges of the same—the variation of the capacity of a condenser the inner coating of which is a bare wire six inches long, the dielectric being air, can be demonstrated—detecting the presence of deposits of dust and moisture, invisible to the naked eye, on insulating material, the detection of the slightest deterioration of insulating materials, etc., but want of space will not allow of the details of such experiments being given. Another use for which this kind of testing apparatus is pre-eminently adapted is in detecting changes in the insulation resistance of dielectrics formed by saturating fibrous material with paraffine or certain other materials.

A case which often occurs in practice will be selected for illustration. A copper wire is covered with two layers (wraps or braids) of cotton yarn, and the yarn saturated with melted paraffine, heated sufficiently to expel all moisture from the fibre. If a five-inch length of this wire is tested as soon as the paraffine is cold, exactly as we tested the one with the vulcanized dielectric, we obtain excellent results. If we test it again after six to twelve hours—depending upon the humidity of the atmosphere—we find some leakage. This leakage constantantly increases until, after from 36 to 48 hours, the wire is no longer fit to convey currents for high potential. There has been no deterioration of paraffine during this time to account for the change; and if we wish to ascertain the reason for the change we must have recourse to the microscope. The electrometer simply tells us that the change *has* taken place; but the microscope will show us *why*. This subject will be again referred to in a subsequent article.

To return to factory work. The methods of effecting combinations of two or more of the substances experimented upon and tested, depended largely upon the nature of the substances themselves. For example, many of them could best be combined while in a melted state; others, by means of mixing rolls which were heated sufficiently to render the substances plastic; and others, by dissolving them in one or more volatile solvents, and after thoroughly mixing the solutions evaporating the solvent or solvents. The solvents thus used were bisulphide of carbon, purified spirits of turpentine, benzole, naphthas, chloroform, alcohol, and ethers. As examples of compositions formed by the above methods the following, of which rubber is an ingredient, are given :

1. A mixture of rubber, rosin and paraffine. The rubber is first dissolved in the rosin (which requires five hours) at a high temperature, and after the mixture has cooled to about 230° F. the paraffine is added, and the mixture well stirred.

2. A mixture of rubber, shellac and chalk. The rubber is first worked upon the rolls, which must be hot enough to soften the shellac, until it acquires the same temperature as the rolls. The shellac, in a finely powdered condition, is then slowly added to the rubber and the two are thoroughly incorporated. The chalk is added last, and the whole mixed for about 15 minutes.

3. A mixture of rubber and paraffine. The rubber is first dissolved in bisulphide of carbon and the paraffine, in small pieces or shavings, added to the rubber solution and dissolved therein, the solutions being stirred from time to time. After the paraffine is dissolved the solvent is evaporated. The process of dissolving, mixing and evaporating is best conducted in a covered vessel heated by means of a steam jacket and provided with a stirring apparatus. It is understood that suitable proportionate quantities of all of the above-mentioned ingredients should be used; and that the examples are given simply to illustrate methods of effecting combinations, for the same combinations can be, and were, effected in other ways.

To describe in detail all of the ways in which the majority of the substances enumerated in Article I were *used* would alone require several articles. In this connection, the term "used" comprises (1) the methods of combining the substances, (2) the different kinds of dielectrics formed by them, (3) subjecting them to heat, cold and to chemical agents, (4) examining them with the microscope, and (5) testing them electrically and otherwise. The following, however, will give a comprehensive idea of the plan generally followed throughout the investigation: The substances were first cleansed of any foreign matters, and a preliminary test of each made with the electrometer. If its specific resistance compared well with that of a chosen standard, or if it possessed properties which might render it useful in combinations, though it lowered the specific resistance of such combinations, it was reserved for further use, but if otherwise it was rejected.

At least four specimens—often more—of each material or composition were applied to copper wires and one to a sheet of paper about 5 inches square. The ways in which the materials were applied to the wires depended, like those of forming combinations, upon the nature of the materials. For example, some were applied while in a melted state; others by means of a tubing machine; others in strips, either spirally or longitudinally; and others, to fibrous material on the wires, while in solution in volatile solvents, or liquefied by heat. If the materials contained rubber and sulphur they were vulcanized. As soon as the wires were insulated they were tested with the electrometer, and the results of the tests of each dielectric, together with its formula, date of testing and the character designating the material written upon a tag affixed to the wire, and also recorded in a book. Each sheet of paper contained one or two specimens. One consisted of a lump of the material stuck to the paper; the other was made by saturating a portion of the paper with the material, whenever it could be done. The formula of the material, date of application and the number or letter designating the material were written on the paper. These specimens were intended principally for ocular examination.

After the wires were tested, one was kept in a dry place free from dust, the dielectric being exposed; the dielectric of the second was covered with lead or tinfoil, and the ends kept sealed; a third was exposed to various chemicals; and a fourth exposed to the atmosphere in and about the factory. In three to four days after the wires were coated they were again tested, and the results of the tests endorsed upon the tags. Many of the materials tested were found, after a few days or weeks, to be worthless for commercial purposes, for the reason that they would deteriorate, or they absorbed moisture too readily; exclusion from light and air caused them to become viscid, etc., etc.; and yet these same materials had tested well when prepared and applied to wires.

All obtainable wires made by others were tested and compared with each other and with those made by the writer. Whenever comparative tests were made, care was taken to have the wires of the same length and diameter, and the dielectrics of the same length and thickness. A difference in length of ⅛ of an inch would sometimes make a considerable difference in the results of the tests.

The potentials used throughout the investigation were never less than about 3,000 volts, and sometimes above 10,000, and the dielectrics of all the wires, whether those made by the writer or by others, when tested electrically or otherwise, for comparative results, were always subjected to the same conditions, if possible.

The present writer maintains that all dielectrics should be tested with currents of high potential—at least 3,000 volts. When a dielectric is tested with a current of from one to one hundred volts, the common practice, there is no particular stress upon the insulation, and the dielectric may show a very high insulation resistance when so tested. But if the testing current has a potential of 3,000 volts and upwards the case is different; and many dielectrics which test well at low potentials cannot endure the strain produced by the high tension current, but break down.

From what has already been written, the reader can form a good idea of the magnitude of the work accomplished by the writer and its importance, which work, from the begining, was conducted with a view to practical results. In the succeeding articles it will be his endeavor to set forth results obtained by careful and conscientious investigation; and he hopes that the information about to be published will prove of interest not only to the scientific world generally but to many now engaged in the manufacture of insulated conductors; and he has reason to believe that much of this information is entirely new—at least it has never appeared in print previous to the publication of these articles.

NON-ARCING METALS.

BY

Reginald A. Fessenden.

WITH reference to the very interesting paper by Mr. Alex. J. Wurts, it may be apropos to recall the experiments of M. Jamin on arcs between different metals. M. Jamin showed that if an arc be placed in an alternating current circuit, there is no change in the nature of the current which passes, if both points of the arc are of similar material; but if of different materials, one wave of the current is more or less suppressed, and a voltmeter placed in circuit acts as if the current were direct and not alternating.

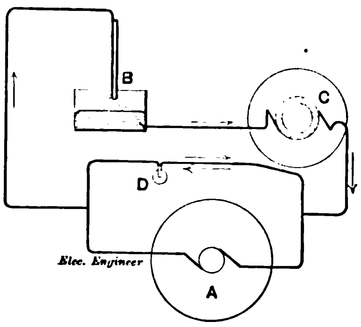
In some experiments made by Mr. John Kelly and myself in 1890-91, it was found that with the mercury-carbon arc (one of the pairs described by Jamin) the suppression of one of the waves was complete and such a circuit, as shown in the accompanying diagram, was found capable of running continuous current motors. It was also used for starting up synchronous motors under load. I am not aware that M. Jamin has put forward any theory to explain this action. But as my own idea of the action which takes place is somewhat different from that of Mr.

Wurts, I subjoin it. Mr. Wurts' theory is that the non-arcing metals have this property by virtue of the arc forming vapors of their oxides, while with the "arcing" metals vapors are formed of the metals themselves, that the vapors of the oxides are non-conductors, and the vapors of the metals are conductors.

While it is true that the vapors of many of the metals are conductors, this is not by any means a universal law. It has been shown by Crookes and others that mercury vapor has a resistance extremely great in comparison with that of air and other gases, and this fact has been used by those who hold that the passage of electricity through gases is due to a kind of electrolysis, as an argument in favor of their theory; for, mercury having only one atom to the molecule in the state of vapor, it is evident that no electrolysis can take place.

It is therefore interesting to find that of the six metals experimented on by Mr. Wurts, the vapor densities of all those which have been determined (*i. e.*, zinc, cadmium and mercury), have only one atom to the molecule in the state of vapor, and that consequently their vapors are probably of very high resistance; in fact, much higher than the vapor of their oxides would be. So we may suppose that the cause of the non-arcing of zinc and the other metals described is due to the insulating properties of the metallic vapors themselves.

There are a few facts which seem to confirm this latter view. First, the suppression of phase by the mercury-carbon arc goes on just the same in an atmosphere of hydrogen as in the air, or, as it has seemed to me, better. Under such conditions, of course, no oxide can be formed. Second, if a mercury-carbon arc be used to run a direct-current separately excited motor, so soon as the arc gets beyond a certain length (in consequence of stoppage of feed, for instance), the motor will stop and run the other way, showing that the other wave has now been stopped out and that the one which was formerly stopped out has taken its place. I have accounted for this by supposing that when the arc gets beyond a certain length, the mercury vapor oxidizes and that the oxide vapor is a better conductor than the carbon vapor. This, however, is not certain; but the fact that I have not been able to obtain the effect in hydrogen gas is in its favor.



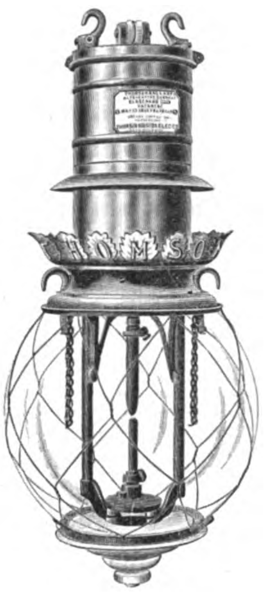
Experiment With Carbon Mercury Arc.

It is possible that a lightning arrester on Mr. Wurts' very ingenious principle might work better with an air gap having its sides of dissimilar materials, as carbon-zinc, so that the lightning discharge could easily pass to ground, but the street railway current could not cross the gap. However, Mr. Wurts is no doubt the best judge of that.

AN ELECTRIC FIRE ENGINE.

The Kummer electric fire engine, made by Messrs. Kummer, of Dresden, uses 50 amperes at 100 volts, or 75 amperes at 65 volts, being 5,000 watts. The pump throws 180 cubic feet of water per second, and with a nozzle of three-quarter inch diameter, gives a height of throw of 100 feet. It weighs 2½ tons, and costs only about half that of an ordinary steam fire engine.

THE THOMSON-HOUSTON "RIBBON-FEED" ARC LAMP.



Thomson-Houston "Ribbon-Feed" Arc Lamp.

A great many efforts—and some of them singularly successful—have been made to shorten the ordinary arc lamp, so that it may be introduced indoors, and be employed where ceilings are low, and where it is naturally desired to keep the lamps beyond the reach of persons whose curiosity is greater than their prudence. It is obvious that the chief difficulty in shortening the lamps arises from the length of the carbon-carrying rod and the fact that the upper mechanism of the lamp must be provided with a tower from which the rod may gradually drop.

In the new "ribbon-feed" lamp just perfected by the Thomson-Houston Electric Company, an important new departure has been made. It will be remembered that in some arc lamps of European production dispensing with the upright tower for the rod, the carbons have been fed inwards on a horizontal plane, while in one instance the lamp was so constructed as to burn curved carbons. The new lamp secures all the advantages of the old form of tower lamp and all the compact symmetry of the others by adopting a metallic ribbon, which occupies practically no space and which, being attached to the upper carbon, allows it to descend in the usual manner, as quickly as consumed. The lamp is but 27½ inches from top to bottom, is only 6 inches wide, and weighs 21 pounds without the globe. The feeding and regulation are extremely good, the arc being always of the same length, perfectly steady, brilliant and free from hissing. The entire mechanism is protected from dust and dirt. The lamp is being made for indoor work on either arc or incandescent circuits. On arc circuits, the lamps are run in series, as usual, and regulate and cut off automatically. On incandescent circuits, they are run in multiple or two in series, a small rheostat or bank of incandescent lamps being used as a controlling device. As will be observed, simple and effective provision has been made for releasing and lowering the globe to clean and recarbon.

DRIVING LOOMS BY ELECTRICITY.

The city council of St. Etienne, France, has decided to apply electric power to all the hand-looms in the city, and contracts have been made with an electric company for the necessary plant. The dynamos are to be driven by water from the city reservoirs. There is practically an unlimited supply of water, with a fall of upwards of 100 ft. The bulk of the enormous output of ribbons ($22,500,000 a year) is the product of house industry. The weavers for the most part own their own looms, and operate them by hand in their own houses. There are 18,000 looms which are thus distributed among the homes of the weavers.

ACCUMULATOR CARS IN ROME.

It is stated that the Omnibus and Tramway Company of Rome has recently made experiments with an accumulator car fitted with motors, batteries, &c., supplied by the Oerlikon Engineering Works. When fully charged, the cells are said to be capable of yielding energy to propel the car 93 miles, so that it is only necessary to recharge every alternate day.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 150 *Broadway, New York city.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XIII. NEW YORK, APRIL 6, 1892. No. 205.

Our country has secured to the common laborer, as no other country has, the fruit of his inventions, and richly has he repaid the provision.—Chauncey Smith.

STUDIES IN INSULATION.

EVERY organization of apparatus for the utilization of electricity for industrial purposes, whether great or small, must in the nature of things comprise four essential elements: First, a means of setting in action, or as it is commonly termed, generating electricity; second, a conductor for conveying the electricity to the point where it is to be utilized; third, insulating media for confining the electricity to the conductor in every part of its course; and fourth, translating apparatus for converting electrical into such other forms of energy as may be required. Whether the electrical energy is to be made available for heat, light, power, chemical decomposition, or the transmission of intelligence, makes no difference, so far as concerns the existence of these primal conditions.

Thanks to the unwearied labors of a vast number of capable investigators, we have during the past twenty-five years gained an extraordinary amount of absolute knowledge respecting some of these conditions. Theory and practice have gone hand in hand, until we have to-day reached results little less than marvelous. The only margin left for improvement in the efficiency of dynamo-electric generators is a beggarly 5 per cent. With electromagnetic apparatus of all kinds for utilizing electric energy, the conditions of maximum efficiency may be said to be equally well understood and practiced. Of the characteristics of the various materials classed as electric conductors, we can expect to learn but little more that will tend to materially increase their efficiency.

In forcible contrast to all this accumulation of knowledge in the other branches of the subject, when we turn to the question of insulating materials and insulation, we are confronted on every side by a vast area of ignorance; it is in fact a territory which may truthfully be said to be almost wholly unexplored. It is certainly strange that this most important, not to say essential department of the field of modern electrical engineering should up to the present time have received so little systematic investigation.

It affords therefore little occasion for surprise, that the series of articles by Dr. Williams, commenced in THE ELECTRICAL ENGINEER of March 16, in which he has undertaken to give the results of his exhaustive and elaborate investigations in this hitherto neglected field of research, should have excited a degree of interest in electrical circles, which to say the least, is quite unusual. The chapters already published evince a broad and comprehensive grasp of the subject on the part of the author commensurate with its practical importance, and this is combined with a minuteness and accuracy of research which even reminds one of the immortal work of Faraday, than which there can be no higher standard.

In the chapters thus far published, Dr. Williams has given quite fully the details of his apparatus, and general methods of investigation. This is to be followed by a separate examination of the different substances employed as insulators, classified in groups, as for instance, gums, resins, vegetable oils, mineral oils, fibres, minerals, etc. The methods of preparing the various non-conducting materials and of applying them to the conductors; an examination of the various modern types of insulated conductors; their relative advantages and disadvantages; the comparative advantages of different protective coatings; the occurrence of faults, latent and otherwise, during the processes of manufacture, and many other equally important matters, will all receive attention. From beginning to end of his investigations, Dr. Williams has kept steadily in view the practical results which may be expected to flow from a thorough knowledge of all the characteristics of insulators and insulating materials, and for this reason alone, wholly aside from the scientific aspect of the question, we are confident that this invaluable series of papers will command the attention of every member of the profession.

INSURANCE OF CENTRAL STATIONS.

ATTENTION was called in these columns last week to the attitude assumed by insurance companies with regard to the use of the electric light, and their attempt to exact higher rates all around, no matter whether the installation was good or bad, was criticised. It seems to us that by such action the companies only encourage bad work, for if careful construction is practically rated with the bad, the inducement to let things go will be rather strong.

But that is only one side of the matter. Central stations are equally the subject of invidious distinction and attack. In proof of this we quote below a letter received by us last week from one of the foremost central station men in the country. He has a superb station, finely built, well equipped and run with the highest engineering ability. Yet none of these qualities availed him, and he has been compelled to meet the insurance agents with a little of their own strategy. He says:

> The very best rate we could get on our station last year was

> $1.80. I placed $200,900 at 80 cents in mutual companies, through the Electric Mutual, and when I was approached this year by the local representatives of the stock companies I told them that we should not consider any insurance proposition from them; that we could find enough mutual companies to carry our business; that I was fully aware of the criticisms they would make on the mutual companies, but did not desire to waste any time discussing them. The result was that the local board took the matter up and made me a rate of 80 cents on my machinery and 65 cents on the building, an even better rate than we got from the mutual companies. The character of our risk entitles us to as good a rate as can be made on any good manufacturing property, but we could not secure this rate, except by these methods. It is needless to say that last year they made every possible effort to convince me and the officers of the company that the mutual companies were valueless. I did not feel a great deal of confidence in some of the companies we were compelled to place our business with, but realizing that we would either have to stand their extortion or take this extra risk, I chose the more independent if not the wiser position.

Evidently this was the best way to deal with the situation, and what one central station manager has thus done, others can do. The difference between $1.80 and 80 cents or 65 cents is too great to be explained on any tenable theory as to the risky nature of the station one year and its safety the next.

SINGLE MOTOR vs. DOUBLE MOTOR EQUIPMENTS.

THE Chicago Electric Club, in its desire to maintain its reputation as an institution fostering lively and timely discussions, has entered into the fruitful domain of electric railroading, and its members are now being treated to a series of papers on the advantages and disadvantages of single and double motor equipments for street cars. At the first session Mr. Elmer A. Sperry, contended for the single motor, and last week Mr. G. K. Wheeler also argued in the same vein. These gentlemen were followed by Prof. S. H. Short who advocated the use of the gearless motor. While the zeal of these gentlemen is to be encouraged, it cannot be denied that the conditions both as to location and management of electric roads vary to such an extent that it would be almost impossible to lay down any hard and fast rules as to the application of any particular type of motor. Besides, street railway companies not infrequently allow the question of price to enter largely into their acceptance of apparatus, so that many arguments, otherwise valid, are ignored. Still, healthy and impartial discussion is always to be encouraged, and the Chicago Electric Club is thus adding to its usefulness.

DIRECT CURRENT TRANSFORMATION.

THE advocates of the continuous current have always maintained as a standard proposition in their arguments that while continuous conversion was theoretically possible its practical realization involved such difficulties and complications as to make the system prohibitory for general use. Not the least weight was given to the fact that continuous current transformation required moving machinery, which necessarily demanded constant supervision, whereas the alternating current transformer demanded no attention whatever. But examples of successful continuous current transformation are constantly increasing in number, and an installation, at Olympia, Washington, which we describe in another page, will show to what extent the method is applicable in practice. In the present state of the art it is true that such transformation demands the employment of moving parts, but who shall say that the future may not produce a continuous current transformer involving nothing beyond molecular movement of its parts?

SUBWAYS FOR WASHINGTON.

A FEW months ago we had the pleasure of printing a very full abstract of the report of the Electrical Commission appointed to consider the question of subways for the District of Columbia. The report has now been printed in full as a Government document, and makes a portly volume, being, as we said at the time, a most valuable and important contribution to the literature of the subject. It presents a very complete survey of work done in Europe and this country, and in the main arrives at conclusions that must be accepted. Its recommendation of the Lynch-Lake terra cotta-conduit is no more than might be expected, in view of the excellent results already obtained with that type of subway in Washington, with all classes of service; and we presume that the plans of the Commission will now be carried out, as laid down in the report and in an elaborate series of maps of the District.

GROWTH OF THE TELEPHONE INDUSTRY.

THE figures given elsewhere in this issue from the annual report of the American Bell Telephone Co., are eloquent as to the steady growth of the telephone industry in America, and as to the profitableness of the business so far as the parent organization is concerned. The first of the fundamental patents has another year to run, and then we may expect to see outside manufacturers coming in to make hand telephones for a variety of uses; but the work of operating exchanges seems likely to remain under existing control for a long time. It is practically from this latter source that the whole of the parent company's income is derived under perpetual contracts, so that even with great activity in the hand telephone field, the companies would not suffer any diminution of value or revenues. That there will be competing exchange service by and by, is beyond doubt, but the strength of the present network of Bell local exchanges and long-distance lines, with local franchises, subways and rights of way, and with solid cash reserves to draw on, may prove equal to the severe test it will get.

Celluloid Storage Batteries.

WE bring before our readers in this issue a new type of storage cell, in which the inventor has sought to decrease the weight and to otherwise avoid the difficulties encountered in lead storage batteries. The employment of celluloid for this purpose in the manner described is quite novel, and if the claims made for the cell are proved in actual practice there ought to be room for this type in many situations, not the least important of which would be that of storage battery traction.

A New Duplex Telegraph.

IMPROVEMENTS in the systems of telegraph at present in vogue are so rare that an advance in this field calls for notice. As such the new duplex telegraph system of Mr. J. J. Ghegan, described in another column, will prove of interest, owing to the fact that it may be said to be both a duplex and a diplex in its nature, and thus to overcome the drawbacks attached to either of these considered alone.

HIGH-PRESSURE STEAM IN CENTRAL STATION WORK.

BY

C. Zehme.

Referring to the article on the above subject in The Electrical Engineer of January 20, I beg to submit the following remarks:

This article mentions among other things that a number of well-known European engineers maintain that condensing steam engines are no longer economical, when pressures as high as 160 or 180 lbs. per square inch are employed. I am astonished that by employing steam of this pressure the economy of condensation can be doubted at all, and I do not think that any German engineers are of this opinion.

A triple-expansion condensing engine, working with steam at a pressure of 170 lbs., and with the most economical cut-off, works with an economy greater, at least by 20 or 25 per cent., than a triple-expansion non-condensing engine. This is, of course, more than enough to cover in the course of a few years the expenses of a condensing apparatus, which consists of a jet condenser connected with the main engine and driven by it. The length of time required to recover this additional outlay depends on the quality and cost of the condensing apparatus, on the price of coal and water, and, with central stations for electric lighting especially, on the length of time the engine runs during the year.

But the greatest importance is to be attached to the cost of the condenser and to the working period of the engine. The time for recovering the cost is longer, when a surface condenser is employed or some independent condensing plant driven by a small independent engine. It appears that the use of such independent single or central condensing plants, especially with surface condensers, has lately come much in vogue abroad; the advantages claimed for them, however, are very doubtful, and only the surface condenser ought to be employed where the water is bad. With regard to the working period it is to be remarked that, when it is long, for instance with electric power transmission, electric railways and with central stations for electric lighting which are furnished with storage batteries, condensing is always very economical, even when pressures as high as 180 or 250 lbs. are employed.

Regarding the triple-expansion engine, mentioned above, it would be necessary, when taking away the condensation, to increase the pressure of the steam 70 or 80 lbs, in order to obtain the same coal consumption. But then we have increased expenses; first, with the engine which must be constructed as a quadruple-expansion; secondly, with the boilers, and thirdly, with the steam pipes. For this money a jet condenser could be paid for twice over.

As to German engineers, they are, I dare say, all of the opinion that with triple-expansion engines working with steam of pressures of 160 or 180 lbs. to the square inch, condensing will lead to considerable economy in working. With all central stations in Germany and with those of neighboring countries, built by German engineers, it has been, and it is, always the principal care, that the central station is near the water, and even where it is impossible to build it there, and where sufficient water cannot be obtained the employment of condensing is not given up. Either the water is brought from distant places or some apparatus is employed for quickly cooling the hot water of the condenser, in order to use it over and over again. Such an apparatus, for instance, exhibited at the Frankfort Electrical Exhibition by Mr. Klein, consists of a wooden-stepped tower, in which the hot water is made to trickle down over a system of parallel boards, while an upward current of air is maintained by means of a ventilator. Such cooling towers have been carried out on a very large scale in many steam plants; for instance, in a large central station for electric lighting in combination with the jet condensers of triple-expansion engines, constructed by Mr. F. Schichau of Elbing, in Prussia; and the results obtained with it have been found to be very satisfactory, in spite of the great cost. The quantity of fresh water added to the circulating water is very small, approximately as large as the consumption of steam.

I do not know any central station in Germany with triple-expansion non-condensing engines, and it will interest you to hear that, because in another part of the same issue of The Electrical Engineer it is mentioned that probably more than nine-tenths of the present existing American stations are so situated that the operation of condensing engines is impracticable.

Finally, I must not omit to remark, that the working with triple-expansion non-condensing engines in central stations without storage batteries may sometimes give rise to a great deal of trouble. If the load is so light that the expansion to the atmospheric pressure takes place as early as the intermediate, or even in the high-pressure cylinder, the engine works very uneconomically and noisily, especially when running at a high speed, and that is still more to be feared with quadruple-expansion non-condensing engines.

Nürnberg, Bavaria.

THE ECONOMY OF CONDENSING WITH TRIPLE-EXPANSION ENGINES.

BY

J. Van Vleck

I have read with interest the above article from your Nuremberg correspondent Mr. Zehme in regard to the matter of condensing with triple-expansion engines, from which it appears that the writer does not doubt the efficiency of condensing under all conditions. I note that he states, in effect, that with a triple engine, and a pressure of 170 lbs., the condenser adds from 20 to 25 per cent. to the engine efficiency, which saving, he thinks, would in a few years cover the expense of operating the condensing plant.

I find it impossible, however, to check these figures, and I do not wholly agree to his conclusion. As a result of my study of cards taken from triple engines, I can only admit, that with pressures of 170 lbs., and above, the work done by the condenser is not much in excess of 15 per cent. of the work done by the live steam, and that when the energy is deducted which operates the air and circulating condensing pumps, there is but 10 or 12 per cent. additional gain. This increase of power and of efficiency may easily be offset by the interest on the cost of the condensing plant together with its depreciation and cost of maintenance.

I have not the time to enter into a more complete explanation of this matter, but should any one take the trouble to plot out (on the same scale) the cards taken from a well-proportioned triple engine, they will be surprised to observe the small percentage of work done by the condenser, from which, as before stated, should be deducted the work required to operate the condenser pumps. With 200 lbs., and over, the strip of work on the card, done by the vacuum, is very narrow indeed, and one almost doubts the advantage of condensing at all.

I believe, however that triple engines should be supplied with condensing apparatus wherever it pays to do so; but this is a nice question to be determined for each specific case. In many instances, for example, it may be impractical or too expensive to obtain sufficient water for condensing purposes; or else, it may be difficult to lead away the outflowing hot water from the station. Then again, if the station should purposely be located near a body of water and away from the electrical centre of distribution, the extra expense for copper conductors may more than counterbalance the advantages of having a condensing plant.

No general rule can determine whether, or not, to employ condensers, as each case has to be considered by itself; the question being one of financial reckoning, rather than of engineering. But the fact that many conditions do not permit of the economical use of condensers should not prevent central stations from reaping the advantages to be gained by employing triple-expansion engines, which with high steam pressure should give magnificent economy. A triple engine is futhermore usually constructed as a three-crank engine which gives a much more even rotation than a two-crank or compound engine—a very desirable feature when "multipolars" are attached.

If, however, a triple engine is to run non-condensing, it should be designed and proportioned accordingly, which is a fact that our German friend may have overlooked. For instance, the non-condensing triple engine now running at the 26th street station of New York Edison Company is proportioned and controlled so that a steam pressure of from 15 to 22 pounds is maintained in the low pressure receiver; whereas, if it were designed as a condensing engine this pressure might seldom exceed 5 or 6 pounds.

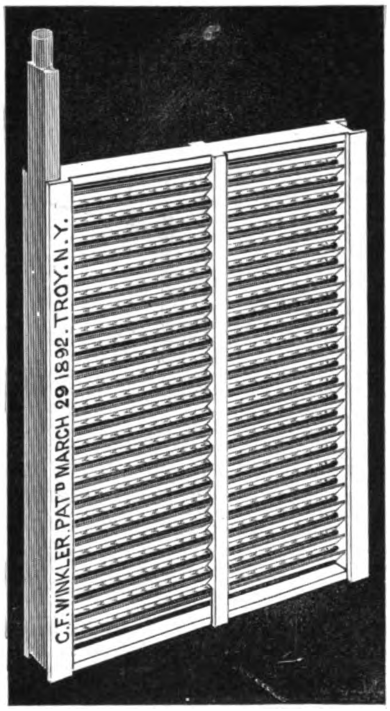
In this connection it is interesting to note that there is now running at the City Roller Mills, at Limerick, Ireland, a large quadruple-expansion engine that was designed for, and is operated, non-condensing, which remarkable engine, it is claimed, delivers a horse power with an expenditure of 1.6 pound of coal, the steam pressure in this case being 185 pounds.

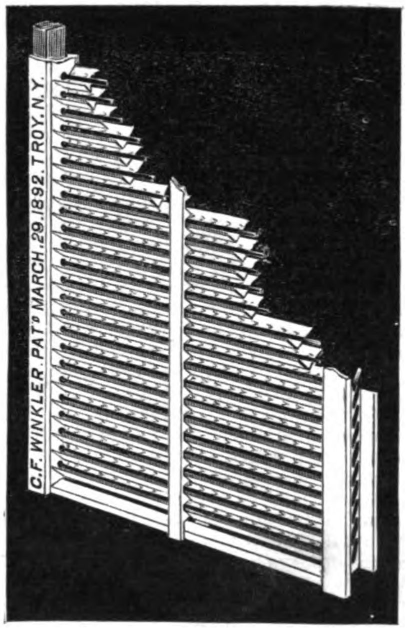
It is true that central stations having variable loads, or having a few generators, should not employ non condensing triple engines, unless storage batteries form a part of their system. Different conditions demand different types of engines. In some cases single-cylinder engines are the proper things; other requirements call for compound engines, while again, other cases demand triple engines. But as to condensing, that should, or should not, be applied, depending on whether it will pay or not. With plenty of water for condensing, and with heavy and constant loads, quadruple engines will undoubtedly fill their place.

I further note in the communication of Mr. Zehme, that in Germany, when water is scarce, the hot condensing water from the engine is sometimes cooled by allowing it to trickle down through a tank through which air is blown. Now, practices similar to that have been tried in this, and other countries, but all such bulky affairs will perhaps never come into prominence in these days of high steam pressures; although I have no doubt that such a contrivance might add greatly to the efficiency of an old-fashioned plant operated by low steam pressure and with single or compound engines.

THE WINKLER CELLULOID STORAGE BATTERY.

SOME months ago we made note of the fact that Mr. Ch. F. Winkler, of Troy, N. Y., was engaged in perfecting a storage cell which was designed to overcome the difficulties heretofore encountered with lead storage batteries, and at the same time effect a large reduction in weight.


C.F. WINKLER. PAT^D MARCH 29 1892. TROY. N. Y.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FIGS. 1 AND 2.—THE WINKLER CELLULOID STORAGE BATTERY.

The Winkler element as now constructed is illustrated in Fig. 1, complete and Fig. 2 shows it in part section. The element consists of a series of celluloid troughs in a frame of the same material. Each trough contains a metallic conducting wire embedded in active material, the wires from the several troughs in each plate being connected to a solid conductor which forms an electrode. The open space between the bottom of each trough and the active material of the trough below facilitates the circulation of the electrolyte and the escape of gases from the active material is made easy by the V-shape of the troughs.

The method of filling the troughs is a simple process, consisting in simply dipping the plates in a pulp-like mixture of the proper oxide of such a consistency that it will run into the troughs and fill the same, any excess being brushed off after drying. A number of plates constitute a cell in the usual manner, and on account of freedom from buckling and the circulation permitted, an even number of plates may be employed.

The electrolyte employed is the usual one or, for greater portability, a non-decomposable electrolytic jelly may be used.

By the construction adopted Mr. Winkler claims that abnormal currents may be discharged without injury to the plates, being only limited by the heating effect on the lugs, and that after an abnormal discharge the battery recuperates very rapidly.

The expansion of the active material, being unopposed, brings no strain upon the plates and as a consequence there is no tendency to buckling or distortion, while the supporting plates, not being acted upon in charging and discharging, do not suffer deterioration in course of time, like lead plates. Owing to the above two facts the size of the plates is not limited, with the consequence that space can be better utilized, the connections made simpler, and the weight reduced from 40 to 50 per cent. The current in charging being equally distributed and confined to the active material alone and not largely to the supporting plate, as is the case with lead batteries, it is claimed that a greater capacity is gotten for a given weight and surface of active material.

It is also claimed that there is no local action between the active material and plates and the cell will therefore retain its charge indefinitely, being very unlike the lead plate in this respect, and that, unlike the plugs in perforated lead plates, the active material cannot easily fall out, and the plates cannot be short-circuited by conducting matter lodging between them. The internal resistance of the celluloid battery is also said not to exceed that of a lead plate.

NOTE ON THE MOLECULAR MOVEMENT IN A CONDUCTOR.[1]

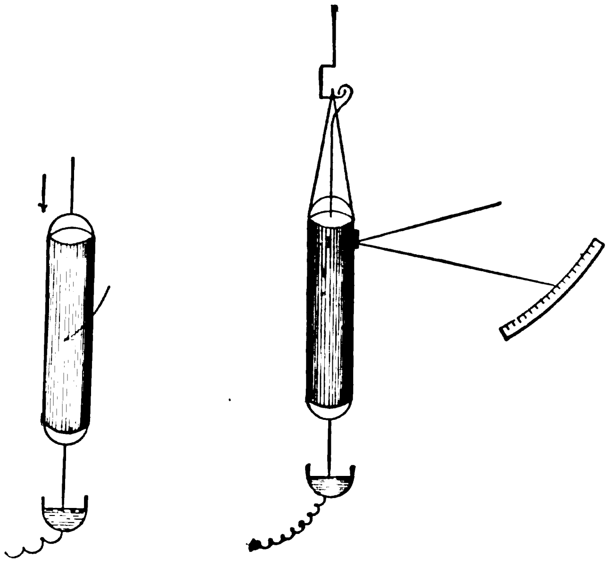
BY PROF. A. E. DOLBEAR.

MAXWELL and others have made experiments to discover whether there was any evidence of momentum in a conductor carrying an electric current. So far as I know all the experimenters looked for a *longitudinal* momentum, that is, one in the direction of the current in the conductor, but no evidence appears to have been discovered that the molecules are thus moved. Still it is as near certain as anything can be and not be demonstrated, that the molecules in a conductor are moved in some way by an electric current. If they be thus moved then there must be momentum in some direction. If it be not longitudinal it may be transverse. If there should be movement in the transvere direction, what kind of experiments would be needed to show it? This is the way the question presented itself to me. When a current is sent through an *iron* wire the latter is twisted, to the right or the left according to the direction of the current. This is interpreted as due to the specific magnetic quality of the conductor, for it does not occur in a copper or other conductor.

Suppose the molecules of a conductor to be *rotated*, each upon its own axis, the axis being longitudinal with the wire, what evidence of such motion would be externally exhibited by the conductor as a whole? Evidently it would be masked altogether in a common wire, for the momentum of any one molecule in one direction would be just balanced by that of the contiguous one in the opposite direction—a condition of things mechanically propagated through the diameter of the wire. In order to discover it, it would be necessary to prevent such mechanical transference of the movement, and this can be done by making the conductor a hollow cylinder. I therefore made a cylinder of gilt paper about 20 inches long and four inches in diameter; this I provided at each end with a bail for suspension, the suspending wire being eight or ten feet long, the lower end of a short wire dipping into a mercury cup as shown (Fig. 1). With this arrangement a decided evidence of twist could be noticed, but on account of the resistance of the gilt paper, a strong current could not be used without so high a voltage, that the paper took fire several times. I then had a thin copper cylinder made of nearly the same dimensions and suspended in a similar manner, and could use a current of thirty or forty amperes. The rotary motions were in the same directions as before, namely—when the current was going down, the twist was always right handed as indicated by the arrow, and of course opposite when the current was reversed.

While there was no doubt about the rotary movement, the weight of the apparatus was so great I concluded to see if one made of lighter material—aluminum, would not give greater amplitude with the same current. A similar cylinder of aluminum foil was prepared and so hung that all tangential movement would be due solely to itself and not at all to any other part of the apparatus, that is, it was mounted with bi-filar suspension. The weight of the foil with its connections were 1.85 oz. (55.6 grams). A bit of mirror was fastened to the upper end, and a beam of sunlight reflected from it upon a scale 16 feet distant, and 25 feet long (Fig. 2).

With this arrangement, the twist produced by the current was such that it was not difficult, by timing the swings and changing the direction of the current, to make the cylinder swing through 90°. A current of 15 amperes swung it through a foot and a half of the scale. It would come to rest at about half the distance of the greatest amplitude of the swing, for each different current employed, and *therefore showed the continuous action of the torsional force for a constant current.* If this be the interpretation of the phenomenon, then the molecules are rotating when there is a constant current, and thus the explanation of the heating effect of the current, is brought back to dynamical and mechanical principles. Adjacent molecules must be rotating in opposite directions at their point of contact, but this vibrating or heat motion necessitates more or less separation, when such rotation goes on; on impact it is arrested so there must be impact and slip, impact and slip, the arrest of motion being the immediate antecedent of the heat, as is friction in any case. These experiments have not been carried out quantitatively for lack of facilities. May be the interpretation is wrong, and some wise one who knows all about it can point out its inadequacy. I think the experiments are new, and may lead to an understanding of what goes on in a conductor when a current of electricity traverses it, if this be not the whole of it.



FIGS. 1 AND 2.

DISCUSSION.

In the discussion MR. MAILLOUX thought the action due to the effect of the current on the earth's magnetism.

MR. TOWNSEND WOLCOTT thought that Mr. Mailloux's remarks would hardly apply to continuous rotation, as such rotation would not take place if the tube were perfectly straight and uniform in resistance.

MR. KENNELLY pointed out that if the cylinder will revolve, any number of other cylinders, inside of, and concentric with it, will also revolve, and this being the case, thought that a solid rod should act in a similar manner under the same conditions.

DR. PUPIN called attention to an experiment of Prof. Braun, of the University of Tubingen[2] in which he found that magnetizable wires twisted in opposite directions, generated opposite E. M. F.'s. He said that Prof. Rowland had called his attention to a current interrupter constructed on that principle, and he thought that the phenomena observed by Prof. Dolbear might be due to a similar cause.

MR. HAROLD BINNEY thought that rotation might be produced by the effect of the bails, as more current would go to one bail than to the other, owing to its tendency to lateral shifting in the magnetic field. This theory was not based upon the supposition that there existed a lack of symmetry in the apparatus. See Fig. 3.

THE CHAIRMAN (VICE-PRESIDENT CROCKER) thought that there would be some lack of symmetry which would cause rotation, and that, if perfectly symmetrical, there would be no tendency to rotate.

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[1] Read before the American Institute of Electrical Engineers, New York, February 16, 1892.

[2] Braun, F., Deformationsstraume, Wied. Ann. vol. 37, pages 97, 107; vol. 38, page 53; vol. 39, page 130.

Mr. Mailloux called attention to Hall's phenomenon showing that, in a wire or cylinder placed like this one in the earth's magnetism, the current is not equally distributed. This, he thought, might partially explain the peculiar actions observed.

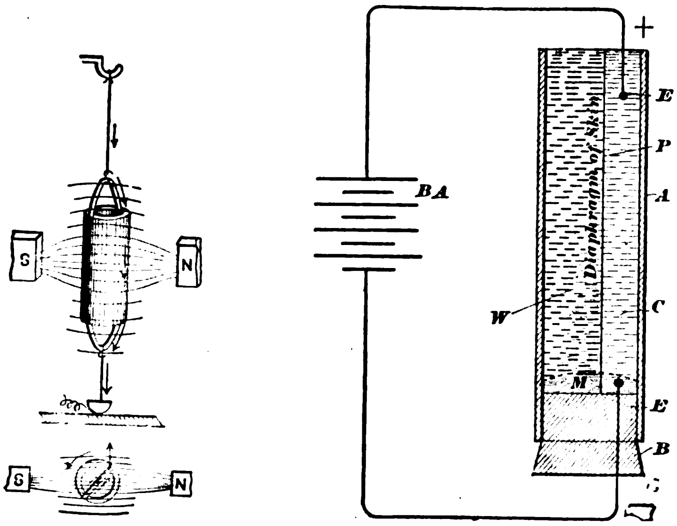
Mr. Wolcott thought the whole effect too small to be noticed there.

Dr. Samuel Sheldon stated that Prof. Hall had used 40 or 50 amperes passing through a Ruhmkorff magnet and a Thomson reflecting galvanometer, with which he observed a very small deflection.

Mr. Carl Hering thought that interesting results might be obtained by shielding the conducting cylinder by a fixed iron cylinder.

The Chairman thought the experiment only suggestive and not conclusive, and that it would have to be carried much further before it could be accepted as a phenomenon of nature.

Mr. Chas. J. Kintner suggested the modified form of apparatus, shown in Fig. 4, and thought that if there were any tendency to molecular movement there, the colored liquid would be forced to rotate through the diaphragm and mix with the transparent liquid on the other side.



Figs. 3 and 4.

c, colored liquid. w, transparent liquid. a, glass tube. b, cork or plug. e e, electrodes. p, porous diaphragm. m, mercury. b a, battery.

The meeting then adjourned.

THE SINGLE-REDUCTION MOTOR.[1]

BY GEORGE K. WHEELER.

It is my opinion that much better results are obtained by a two-pole single-reduction motor than by the four-pole, for the reason that it is much lighter, simpler in construction, has a smaller commutator, half the number of bobbins on armature, also half the number of brushes, and is much more economical to maintain. One of the leading electric manufacturers has produced a motor that I think meets all the requirements for ordinary street railway service; this motor is 15 h. p., weighs about 2,000 pounds complete, including gear, pinion and gear case.

The tendency of modern improvement in railway motors is to diminish the gearing, and I do not think that anything is to be gained over the double-reduction motor by placing two sets of gears and pinions one on each side of a single-reduction motor, as it not only increases the friction losses, but adds an additional weight to the motor, and if the motor frame and armature shaft are properly constructed there is no liability of straining or breaking either by reason of placing the gear and pinion on one side only. It is stated by a number of competent electrical engineers that the placing of one motor on a truck is ample for all ordinary street car service. By experience I have found that with a truck having but one motor attached to one axle, the wheels on the axle to which the motor is attached do not brake as quickly as the free wheels and flats are thus formed on the free wheels on this account; also that it is a difficult matter to ascend grades over three per cent. and that it is next to an impossibility to operate a car so equipped, during the winter months. It is also advocated that the proper method is to gear a single motor to both axles; this in my opinion is open to serious objections. In gearing a single motor to two axles of a truck, it is almost impossible to keep the wheels perfectly true.

It is for these reasons that I believe the best results are obtainable by connecting a single motor to each axle of a truck. It may be argued that there is twice the liability for trouble where two motors are used, but experience proves that this is not exactly so, for by this method you obtain the proper traction and benefit of all wheels, and in case of extra load you have ample power to operate the car under all conditions of service, and in case of injury to any part of one motor, it can be disconnected and the car operated until an opportunity offers to make the necessary repairs.

A single-reduction motor should be so constructed as to give the greatest possible distance between the bottom of motor and top of rail. With the best form of motors which have up to the present time been constructed, the greatest distance obtainable between a 15 h. p. motor and top of rail is 4½ inches when placed on a wheel 30 inches in diameter. I strongly recommend the use of larger wheels, either 33 or 36 inches in diameter. With a motor mounted on 36-inch wheels this will give a clearance of 7½ inches, which is more than ample to clear ordinary track obstructions; and if the motor is thoroughly protected in its frame, it will not be necessary to use motor pans, which have been a necessary evil in connection with double-reduction motors. It may be argued that a car equipped with 36-inch wheels requires an excessive amount of current to operate, but this is not a fact. On a test which I made more than a year ago on a car equipped with 36 inch wheels and a car equipped with 30-inch wheels, the same motor equipment and car of same length and weight, operated over the same length of road on the same day and by the same man, total length of line being 16 miles, it was found that the car equipped with 36-inch wheels required about ¾ of a horse power more on an average than the car equipped with 30-inch wheels, although the 36-inch wheel car required more current in starting and climbing grades; but it would run longer on the level by momentum, and thus average up the current consumption. With the present form of single-reduction motors I think that the 33-inch wheel is of ample size.

On tests which have been made with the best types of single-reduction motors, they have been found to be from 8 to 10 per cent. more efficient than the double reduction, and are capable of attaining a much higher speed under various conditions of service. On a recent test which I made on an over-country road, being some 11½ miles in length, the car was 34 feet in length, and with 25 passengers, total weight of car was 23,700 pounds; the car was equipped with double trucks having two 25 h. p. single-reduction motors to each car. The maximum speed attained was 32 miles per hour, climbing grades of 4 and 5 per cent. at the rate of 17 miles per hour. On a car 16 feet in length, equipped with one 15 h. p. single-reduction motor, the maximum speed attained was 25 miles per hour on a level, and the car in climbing grades of 4 and 5 per cent. would not attain a speed of over five miles per hour.

THE BEHAVIOR OF INSULATING MATERIALS UNDER THE ACTION OF HIGH POTENTIAL DIFFERENCES.[1]

BY H. BLECKLY BOURNE AND W. FOX BOURNE.

Electrical engineers have recently been devoting a great deal of attention to the transmission of energy by small currents at high pressures; and it is clearly advantageous to increase the potential difference until the expense of insulating the apparatus neutralizes the saving in copper. The question of insulation is, of course, the main difficulty, for as we increase the p. d. many substances which are ordinarily considered insulators have to be regarded as fairly good conductors. Numerous experiments were shown to illustrate this point, the current being obtained from a "Hedgehog" transformer capable of developing about 25 h. p. at 100,000 volts, which had been lent for the occasion by Messrs. Swinburne & Co.

The question of sparking distance in air does not seem to be of any great practical importance, but as it has recently been referred to, the following figures, obtained at Messrs. Swinburne & Co.'s works, may be of interest:

Sparking Distances between Needle Points.

P. D. in volts.	Sparking distance in inches.
3,000	0.11
14,900	0.5
24,000	1.0
39,000	1.6
50,000	2.2
62,000	2.8
74,000	3.5
92,000	4.5
97,000	5.0

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[1] Abstract of a paper read before the Chicago Electric Club.

[1] Abstract of a paper read on March 11, before the Old Students' Association of the City and Guilds of London Institute, at the Central Institution, South Kensington.

Sparking Distances between Plates 2⅛ Inches in Diameter.

P. D. in volts.	Sparking distance in inches.
18,000	0.16
20,000	0.40
44,000	1. 0
70,000	2. 0
90,000	3. 0
105,000	4. 0

The above results were obtained on a cold, dry day, but can only be regarded as approximate, as the distance was found to vary a good deal with atmospheric and other conditions, so that concordant results could not always be obtained on different days. By striking an arc between electrodes of tin wire, which gradually melted, a flame of considerable length was exhibited, and it was pointed out that the length to which an arc could be drawn depends very largely on the current strength available.

It was next shown that, for overhead work at very high pressures, even oil insulators of the best design are quite useless. Wires from the transformer were connected to the stalk and grooves of an insulator which had been dried and filled with clean resin oil; brush discharges immediately occurred over the surface of the porcelain, and when a P. D. of 600,000 volts was reached a spark jumped from the wire to the stalk. Two wires were placed near the ends of a piece of slate about a yard long, and sparks passed freely from the wires to the slate; and a sort of arc lamp was arranged with slate pencils for electrodes. A similar conducting power was shown to be possessed by vulcanized fibre and asbestos mill board. The discharge does not break down or perforate these substances; they behave exactly like conductors. A curious effect was shown with a long piece of slightly damp wood, numerous small arcs being formed, which finally ignited the wood.

The experiment with the oil insulator, and other experiments shown, point to the fact that surfaces of insulating materials, unless absolutely clean and dry, have considerable conducting power. A discharge may sometimes take place on the surface of a non-conductor across a distance much greater than the striking distance in air, and once a discharge has started an arc is formed. A cable insulated with a layer of rubber a foot thick might be useless for 50 or 100 thousand volts, if it had even a small crack. This creeping discharge was also shown by the now familiar experiment in which a pair of discs are separated by a large sheet of glass. In one of the experiments shown, the glass did not break, though the discharge passed through it; and it was found that if there ever had been a perforation, the heat of the arc had fused the glass and entirely sealed up the hole.

The potential difference required to break down or perforate insulators is quite a different matter from the discharge over their surfaces. A number of samples of broken-down insulators were exhibited; they were materials which had been tried for use in condensers, and were in the form of thin sheets of mica, celluloid, or paper impregnated with various resins and waxes, etc., and were about six mils thick; they had been perforated with potential differences varying from 2,000 to 6,000 volts. A piece of cable insulated with a layer of vulcanized rubber of the best quality, rather over one-eighth of an inch thick, was shown; it had withstood 50,000 volts for 25 minutes. In such cases the time element is of great importance, and the dielectric is usually found to become very hot before it breaks down. This fact indicates a very important difference between the effects of direct and alternating currents on insulators.

Whenever, as in the case of a concentric cable, the two conductors are at all close together, we have a condenser which is being rapidly charged and discharged. Now in the case of most solid dielectrics there is a good deal of soaking in, and consequent loss of energy, which manifests itself as heat. This was made very evident in the case of a condenser which was tried at Messrs. Swinburne's works. This condenser was made of sheets of tinfoil insulated with paper soaked in paraffine wax in the usual way; its insulation, measured with a steady E. M. F. of 240 volts, was about six megohms; and the active surface of plates was 5,000 square inches. When it was connected across a 2,000-volt circuit, it was found to absorb more than a horse power, so that a considerable rise of temperature was not surprising. But it was also noticed that its capacity rapidly diminished, and finally disappeared, which was, on investigation, found to be owing to the fact that the foil had melted and so become disconnected from the circuit. Another condenser, made with glass plates one-tenth inch thick, broke down with 2,000 volts after about five minutes, apparently owing to internal cracks caused by the heat evolved. In the case of the sample of rubber-covered wire above referred to, the compound in which the braiding had been soaked melted in five minutes and the rubber became quite softened by the heat in about 15 minutes. This heating effect is much less in the case of most fluid insulators, but seems to be more important in oils having a high specific inductive capacity.

Experiments were then arranged to show some actions of oils under high voltages. A plate was immersed in castor oil, and a point supported a short distance above the surface. On switching on the transformer, a distinct depression was produced on the surface of the liquid. Two plates were then arranged, one over the other, separated by a layer of castor oil on which was floated some paraffine. When the plates had a difference of potential of 20,000 or 30,000 volts, the castor oil rose in a sort of hill, owing to the fact that its specific inductive capacity is higher than that of paraffine, so that by its movement the capacity of the arrangement is increased. It was also shown that particles of sawdust in resin oil were formed into chains, producing a discharge across a considerable distance.

The experiments were concluded by sending the current from the transformer through a number of vacuum tubes. These were of course brilliantly illuminated, but the current was not maintained for more than a few seconds, as an intense heating of the glass and electrodes ensues, which usually breaks the tubes. This fact renders it difficult to measure the power absorbed, but it was estimated from the primary current and voltage that a comparatively small tube may easily be made to absorb 2.5 h. p. while giving a light of only a few candle power.

In the above-described experiments the potential differences were measured by a direct-reading electrometer loaned by Messrs. Swinburne & Co. This and the transformer are intended to be used for experiments to be shown by that firm at the Crystal Palace Exhibition.

BEGINNING ELECTRIC RAILWAY WORK IN BROOKLYN.

WITH regard to the coming electric railway work in Brooklyn, the *Eagle* says:—"The officers of the Brooklyn City Railroad are anticipating the greatest activity. 'We will have to hustle,' said President Daniel F. Lewis. "The first thing we shall do, and we will commence work instantly, will be to enlarge the present temporary power house on Second avenue and Fifth street, so that it shall have a capacity of 1,600 h. p., instead of the present 800. We shall build additional cars and by Decoration Day we expect to be running an increased service on the Second avenue line, to replace the steam motors on Third avenue, from Twenty-fifth street to Fort Hamilton, and to operate the Hamilton avenue line from Twenty-fifth street to Hamilton ferry. To do this we shall have to work with the utmost rapidity and shall, in fact, give out our contracts very soon.

"The next step," Mr. Lewis continued, "will be to complete the equipment of the southern division and to commence work on the central division, possibly at the same time tapping a part of the crosstown division. To do this we shall build a large permanent power station on the water front we now own at the foot of Fifty-second street. This, when completed, will have a capacity of perhaps 5,000 h. p., certainly not less than than 4,000 h. p. This will run the cars of the Third avenue, the Court street and the Furman street lines which, with the others I named previously, form the southern division. It will also supply the power to a part of the central division. The Myrtle avenue, the Greenpoint, the Graham avenue and the Crosstown will probably be supplied with a current from a power house which may be built near Fulton ferry. We haven't completed the details yet, nor decided exactly what we will do with the eastern district lines. We will have to have another power house over there in some central location and on the water front. You see, a water front is almost a necessity for all these stations, as it greatly facilitates and cheapens the transportation of coal and the removal of ashes."

"How long will this take, Mr. Lewis?" asked the reporter.

"I should judge," he answered, "about two years, but, as I said, we will have to hustle."

"What will the cost be?"

"About $6,000,000, I should judge. We haven't perfected the financial arrangements yet. As you know, we have $3,000,000 in bonds in our treasury which we can issue at any time. Whether we shall issue these or more stock we have not decided. We estimate that we can use half the cars that are now being run, and this will save us much money. The rest will have to be sold at a loss. We probably will lose little or nothing on the horses, as we can gradually use them up. You see, a horse lasts about four or five years. In the two years or longer before the trolley can be entirely introduced we can use up all or nearly all our horses. The tracks will have to be largely replaced, or at least strengthened."

Mr. Lewis further said that he was perfectly satisfied with the ten-mile-an-hour speed limitation and with the amount of bonds required for the protection of the city against accident.

President William Richardson of the Atlantic Avenue Company was asked when he should begin preparations for the introduction of the trolley system on his lines and replied:

"We hope to have the line from South ferry to Greenwood cemetery running by June. We shall introduce electricity on the line first as an illustration of the workings of the system, and it will be put on other lines thereafter, first on those lines where the property owners show the greatest anxiety for it.'

SOME RECENT TELEPHONE SUBWAY WORK.

BY J. P. M'QUAIDE.

The construction of telephone subways has always been considered by municipal authorities as a matter of only small expense to those companies contemplating such work. Due credit has never been given to the different companies for the enormous outlay of time and money that is necessary to construct a proper and perfect subway. In the city of Boston many trenches were dug and many manholes are built in places where at high tide there is three feet of water in the manhole. The expense of keeping the subway dry can hardly be estimated.

In Haymarket Square, Boston, one trench 136 feet long 4 feet wide and 7 feet deep required three weeks to dig on account of water and gas mains to be moved, sewers to be cut through and rock to be blasted; and after all that expense and trouble it was found impossible to lay the conduit straight, so in that trench they laid 12 cement lined pipes on a curve that was 6½ feet off the centre in 136 feet. Cables have been successfully drawn through these pipe and are in perfect working order to-day.

There has been no telephone subway construction done that it was possible to draw plans of before doing the work and live up to them. To illustrate this, in New York City the subway company adopted a plan for a manhole to be used throughout the city, to be the standard manhole. There are built in New York City nearly 3,000 manholes; of this number one manhole was built that was very near the plan adopted; none of the rest was anything like it. On South 5th avenue, 24 cement-lined pipe were laid in the following manner: At the manhole at Broome street they were able to get plenty of width to the trench but no depth to speak of. As the next manhole was approached the trench became narrower but deeper, until, when the manhole was reached there was a trench 18 inches wide and 6 feet deep. They started laying the pipe 12 wide and two rows deep, gradually narrowed them, and dropped them down until they came out at the next manhole 2 wide and 12 rows deep. These ducts are all filled with cables that are working perfectly.

It was expected in the Albany work, it being a small city, that not many obstructions would be met. But we found that the Albany folks of 100 years ago had wooden water pipe and wooden sewers.

The New England Telephone Company was the pioneer in the subway business and the good example set by it is being followed by the companies in cities of the first and second class with the exception of a few where the municipal authorities refuse to grant them the privilege to bury their wires at their own expense. Why under the sun, they should refuse this privilege, I cannot imagine.

ELECTRIC RAILWAY EARNINGS.

We have received the following business statements of three electric railways:

BINGHAMPTON (N. Y.) STREET RAILROAD COMPANY.

Thirteen miles of track, of which ten miles is the trolley system.

Statement for Quarter ending September 30, 1891.

Gross earnings		$17,670.29
Operating expenses (excluding taxes)		8,568.64
Net earnings		$9,101.65
Interest on funded debt	$2,730.00	
Taxes	1,004.93	
		3,734.93
Net income for three months		$5,366.72

WATERTOWN (N. Y.) STREET RAILROAD COMPANY.

Statement.

Gross earnings, May 20 to November 20, 1891	$12,365.06
Expenses, including interest	4,614.22
Net income for six months	$7,750.84

BUFFALO RAILWAY COMPANY.

Statement for Six Months, July 1*st*, 1891, *to January* 1*st*, 1892.

Gross earnings	$519,273.64
Operating expenses, including taxes	343,310.49
Net earnings	$175,963.15
Interest on funded debt	117,545.83
Net income for six months	$58,417.32

Operating cost, including taxes, $66\frac{11}{100}$ per cent. of earnings.

The gain in net earnings on the same period of last year was $30,415.38, equivalent to $20\frac{89}{100}$ per cent.

THE TROLLEY SYSTEM IN BOSTON.

An effort is being made to introduce the trolley system in place of horses on the street car lines of Philadelphia. There is a powerful protest against the change, however; and the remonstrants allege that wherever the trolley system has been introduced in a large city, it has so fully demonstrated its objectionable qualities that it has excited general discontent and a desire to get rid of it at any cost. Boston is one of the large cities where the trolley has been introduced, and it is proper to say that the allegation of the Philadelphia citizens is not true. On the contrary, the system is giving satisfaction, and it is rapidly being extended here.—*Boston Herald.*

TELEPHONIC EPISODES IN EUROPE.

Employees of the telephone company at Vienna have informed the Minister of Commerce that the Director of Telephones has been in the habit of instructing subordinates to call him to enable him to listen whatever the Emperor of Austria is talking with ministers or councillors or any prominent financiers.

Merchants using the telephone accuse the same Director of having immoral relations with female employees. Pending an inquiry, a Government official takes the place of the Director.

In the British House of Commons on March 22, the Right Hon. Sir James Fergusson, Postmaster General, in opposing a private bill for the establishing of a new telephone company, announced that the Government would promote a measure placing the telephone trunk lines in the hands of the post office department, which would use the present telephone systems in alliance with the trunk.

Legal Notes.

THE WESTERN UNION AND UNION PACIFIC CONTRACT ANNULLED.

The contract of 1881 between the Union Pacific Railroad Company and the Western Union Telegraph Company, by which the latter conducts the commercial telegraph business on the former's lines, must be set aside, according to a decision rendered by Justice Brewer of the Supreme Court. The case was begun in the Circuit Court for Nebraska, by the title of the United States vs. the Western Union and Union Pacific Companies, under the provisions of the act of the Fiftieth Congress known as the "Anderson law." By that law, railroad and telegraph companies which had been assisted in any way by the United States in the construction of railroad or telegraph lines were required to operate, by their own officers and employees, telegraph lines for all purposes, and exercise by themselves alone all telegraph franchises conferred on them, and the officers of the Government were directed to bring suit to annul any contract entered into in violation of the rights conferred upon the companies by the government in the franchises or grants referred to. A decree is to be entered in favor of the complainant, setting aside the contract of 1881.

Society and Club Notes.

THE ST. LOUIS ELECTRIC LIGHT CONVENTION.

President James I. Ayer, of the National Electric Light Association, has already begun to make extensive preparations to entertain the delegates to the National Convention of the Association, which meets in St. Louis next February. Isaac Taylor, the architect who has charge of the building of the new Mercantile club house at Sixth and Locust streets, has promised to complete the building by February in order that the Convention can meet there. The faculty of Washington University, the Mercantile Club, St. Louis Engineers' Club and the Merchants' Exchange will heartily co-operate in entertaining the delegates, among whom are many of the brainiest men in the country, and men pre-eminent in the science of electricity. President Ayer has received a letter from Mr. E. R. Weeks, general manager of the Kansas City Electric Light Company, instructing Mr. Ayer to call upon him for any assistance he may be able to render in making the Convention a success.

Lectures on Physics.—A course of six descriptive lectures will be given at 335 South Halsted street, Chicago, in the lecture-room over the public reading-room under the auspices of the Hull House. They will treat of the subject in an elementary manner, having in view a more comprehensive course in the fall. The importance of physics to those engaged in electrical work is acknowledged; it is an interesting study and of great practical value. The electrical mechanic and those interested in electrical work should not miss this opportunity. The lectures will be given every Wednesday evening at 8 p. m., beginning April 6.

Literature.

Heroes of the Telegraph. By J. Munro. The Religious Tract Society, London; *Fleming H. Revell Company*, New York and Chicago. 288 pp. Illus. Cloth. Price, $1.40.

THIS is a very interesting collection of biographical sketches of such men as Wheatstone, Morse, Edison, Bell, Hughes, Siemens, Lord Kelvin, Sir W. Siemens; with briefer notes on Gauss and Weber, Bain, du Moncel, Elisha Gray, Werner Siemens, etc. These careers embrace the leading events in telegraphic and telephonic development, and Mr. Munro has presented them in an attractive manner, so that while the story pleases, not a little, information is derived as to electrical principles and apparatus. It is a pity some of the biographies were not brought down to a later date, and that better portraits were not given.

Secondary Batteries. By J. T. Niblett. London, *Biggs & Co.* 267 pages; 5 by 7 inches. Price, $1.40.

THE progress which has been made, or rather the working improvements effected, in storage batteries in the last few years have been such as to render their enumeration in book form a timely undertaking, and the volume before us is well calculated to bring the reader well abreast with this progress. The author has wisely touched but briefly on the types of storage cells prominent a few years ago and brings them forward merely to present a continuous narrative. Their description serves a useful purpose, however, in showing in what direction improvements have been made. Following this the author takes up the cells of the Planté type, and describes the principal batteries under this head. This is naturally followed by a description of pasted or Faure storage cells, or if we are to follow the decision of the courts of this country, Brush cells. The various methods described in the construction of these cells will give the reader an excellent opportunity for comparison between the different types. The author next takes up the lead, zinc, copper, alkaline and other batteries, including the Reynier, Waddell-Entz, Jablochkoff anti-accumulator and others. The final chapter is devoted to the description of what the author calls solid storage cells, in which a solid electrolyte is used such as we find in the Schoop battery and in the Barber-Starkey cell. To this is added an appendix giving the various lead salts employed in the manufacture of storage batteries and the manner of their preparation, and also the various characteristics of the sulphuric acid employed in storage battery work, together with other useful information.

Taken as a whole the book is an excellent record of the present state of storage battery work, and must be commended for the general excellence of its engravings.

Die Versorgung von Städten mit Elektrischem Strom. (*The Supplying of Cities with Electric Current.*) Edited by F. Uppenborn, engineer. Berlin, *J. Springer*, 1891. Size, 7½ by 10½ inches. Price, $6.40.

IF the late Frankfort Electrical Exposition, which was so eminently successful in other ways, has been instrumental in furthering the interest of the German public in electrical matters it has certainly fulfilled its mission, but in addition to that primary object, it has served to place before electrical engineers, in concrete form, what may be considered the latest electrical advances in Germany. This standard practice may be said to have been shown, not only in the exhibits, but in what is termed the "Jubilee Book," issued to commemorate the meeting of German Municipal Governments, held in connection with the Electrical Exhibition.

This work consists of the description of the principal electric light stations installed by the most prominent manufacturers in Germany, including Siemens & Halske, Schuckert & Co., Ganz & Co., Thomson-Houston International Electric Co., C. E. Fein, and a score of others.

The descriptions are not merely perfunctory tabulations of figures and apparatus employed, but take into consideration thoroughly the problem to be solved in each case and the methods employed. The illustrations, which are of a high order of excellence, serve to make these descriptions intelligent so that even the English reader will be benefited largely by an inspection of the diagrams alone.

While it will be conceded that the art of electric lighting was created in America, a glance at this work must convince the reader of the fact that although somewhat slow in getting to work, the Germans have built all the more solidly for it, and almost without exception the stations and apparatus described show great care in design and solidity of execution. It would take us too far to enter into a discussion of the various ways in which German practice differs from ours, but we would draw special attention to the comparatively large number of instances in which storage batteries are used for central station work, and evidently to good advantage. This is a practice which, it is safe to say, could be profitably followed in this country, and it has always seemed to us a matter of regret that no real attempt has been made in this direction. We are aware that one or two small storage battery installations for central station work have been attempted, but on such a small scale that the results were not, and could not be, satisfactory. Taken in connection with central station work, we think the results of German and English practice warrant the assertion that storage batteries can be profitably employed in this field. In conclusion we might say that every central station manager can derive profitable ideas from this work, which, under the able editorship of Mr. Uppenborn, has been executed in a manner best suited to bring out the salient features of central station work.

Twenty-Third Annual Report of the Board of Railroad Commissioners (of Massachusetts). Boston, 1892.

The report of the Massachusetts Railroad Commissioners is interesting to the electrical profession principally on account of its information respecting the progress and results of the operation of electric railways in that state, not easily obtainable elsewhere.

The Commissioners again call attention to the necessity of more stringent legislative limitation of the speed of electric cars in the streets, in the absence of some efficient form of fender to serve as a protection for foot-passengers. They say and doubtless with truth, that no fender has been yet put into use which is efficient for the saving of life under the varying conditions presented by the streets and roads now occupied by electric railways. Some of the difficulties of the problem however have been removed by the use of the long and high double-truck cars which are being introduced as rapidly as possible by the West End Company of Boston. The statistics of accidents on the West End system for the year ending September 30, 1891, show a record of accidents by horse cars, 122, or 1 to 105,528 miles run, and by electric cars, 82, or 1 to 55,953 miles run. From which it appears that there are nearly twice as many accidents by electric as by horse cars, although the exhibit of the former still remains more favorable than that of the steam railroads. It is of course mainly a question of speed, and not of the particular motor used. The commissioners say: "Although motormen too frequently go at forbidden rates of speed, it speaks well for their general faithfulness, skill and alertness that so few accidents have occured;" a tribute of which the motormen are certainly not undeserving.

The Commissioners devote considerable attention—but certainly no more than the gravity of the situation calls for—to the question of the crossing at grade of steam railways by electric street lines. While no serious accident of this nature has as yet happened in the state, the commissioners very justly observe that the indications are that such accidents will happen. In reference to this matter they say:

"The rapidity with which electricity is supplanting horses as the motive power for street railways demands attention, in consequence of the fact that there is much greater danger in the passage of an electric car across steam railroad tracks than there is in the passage of a horse car across such tracks."

"Electricity is a more uncertain motive power than horses. Further than this, a car propelled by electricity is more likely to come to a standstill on a crossing than anywhere else on its route. This is owing to the difficulties of making proper connections at railroad crossings, to the increased power required to propel the cars across the steam railroad tracks, and to the chance that the jolting of the car will throw the trolley-arm off from the wire."

"Of all the dangers at grade crossings, there are none which compare in magnitude with those growing out of the electric car service. A permit should not be granted to a street railway to run electric cars across steam railroad tracks unless it is practically a matter of necessity. Where such a permit is granted, the law should require suitable crossing frogs to be laid, and signals interlocking with the gates to be provided."

There were on September 30, 1891, 28 street railway companies in the state using electricity as a motive power, all overhead or trolley systems, excepting two of minor importance on which storage batteries have been introduced. The aggregate mileage of electric railway has more than doubled during the year covered by the report, being 279.44 miles in 1891, an increase of 128.17 over the figures of 1890. The West End Company reports 81.23 miles, an increase over the preceding year of 15.77 miles.

As nearly all the principal street railways in the State are still operated with a mixed system of horse and electric cars, it is impossible to extract from the tabulated returns of receipts and expenses of operation any results of especial interest in the way of comparative statistics. It is worthy of note, however, that the total number of passengers carried on the street railways during the year was 176,090,189, being an increase of 11,205,746 over the number carried the preceding year, and exceeding the aggregate number carried on all the steam railroads in the State by no less than 68,818,347. The whole number of horses reported was 10,640, being a falling off from last year of 601, from which it appears that the great increase in the number of passengers carried by electricity has not as yet affected, to any marked extent, the emancipation of the horse. This eminently desirable result will, however, inevitably be brought about in due time.

Since the date of the report the legislature of Massachusetts has authorized the use, by existing steam railroads, of electric power, and it is not improbable that the next report of the Commissioners may embody some interesting information on this subject.

Letters to the Editor.

WORKING EFFICIENCY OF TELEGRAPH LINES.

On page 130 of the last edition of Mr. Franklin L. Pope's work on the Electric Telegraph we find:

"When key at B is open, the entire length becomes *positive*, being wholly charged from the positive pole of battery at A (Fig. 1.)

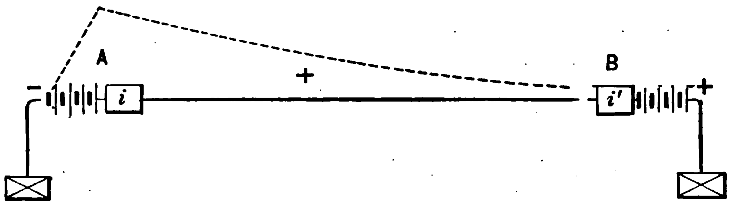


FIG. 1.

"With both keys closed, if a galvanoscope were to be connected between the point *o* and the earth (Fig. 2), it would indicate no current, because the potential *o* is at zero. Hence the quantity of current going to line from battery at A will be *the same as if the line were connected to the ground in the middle*—that is, at a point 100 miles from A."

As the foregoing statement has been emphasized by italics in the original, and several inquiries having been made privately to ascertain the true meaning involved, you will confer a favor by explaining how it is that the battery of 100 cells at A is furnishing just as much current to line through a resistance of 2,000 ohms as it does when a ground is attached to the middle of the line, reducing the resistance of the circuit of battery A to 1,000 ohms. Is it true that there is just the same consumption of zinc in one case as in the other, and are the formulas on pages 130 and 131 reliable guides?

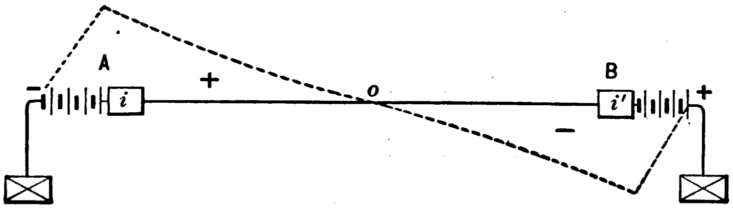


FIG. 2.

F. W. JONES.

NEW YORK.

That the battery of 100 cells in the case cited furnishes the same amount of current to the line, and that the consumption of zinc is also the same, whether the line of 1,000 ohms be connected to earth at its extremity or whether it be joined to another line of 1,000 ohms, having at its remote end another battery of 100 cells with agreeing poles, will, I think, appear from the following considerations:

In the first case we may assume—

E. M. F. of battery at A	100 volts.
Resistance of line, 1000 + instrument, 100; total	1,100 ohms.
Current (by Ohm's law) $\frac{100}{1100}$=	.099 ampere.

In the second case we have therefore—

E. M. F. of battery at A + battery at B	200 volts.
Resistance of line, 2,000 + instruments, 200; total	2,200 ohms.
Current (by Ohm's law) $\frac{200}{2200}$=	.099 ampere.

It appears, therefore, that the strength of current on the line remains unchanged, being .099 ampere in each case, and it necessarily follows that the consumption of zinc *per cell* must remain the same. And inasmuch as the quantity of zinc consumed, not counting local action, is a measure of the quantity of current generated, it seems clear that the battery at A must furnish in each case the same quantity of current to the line.

FRANKLIN L. POPE.

THE DORMAN TRANSMISSION PLAN.

In your issue of March 23, Mr. Peake criticises Mr. Dorman's high pressure transmission proposition, and points out the difficulty of insulating the machines. He evidently loses sight of the fact that where dynamos or motors are run in series their insulation resistance need be up to their individual output only. If Mr. Peake should put 260 of his four-thousand-volt constant current machines that were safe for that pressure in series, they should generate one million volts without additional insulation strain, if a corresponding number of motors of the same capacity and insulation were placed in the circuit they would stand the strain; I have seen several hundred motors working in series for months, without trouble, on a 5,000-volt circuit. They were very crude machines; not one of them would have been safe with 300 volts across their terminals, yet those same machines were used for years with apparent impunity in all sorts of industries scattered from basement to attic over a large city. If the circuit was maintained unbroken and kept clear of grounds, we considered it harmless. While for long distance transmission of power, the alternate current may become popular, it is certain the maximum capacity of the series direct current arrangement has scarcely yet been approached.

J. C. HENRY.

NEW YORK CITY, March 23, 1892.

Personal.

MR. J. STANFORD BROWN has resigned the position recently accepted by him as general manager of the *Electrical World*, etc., and will hereafter have no connection with that concern. He has resumed his practice as an electrical engineer and expert, at his old offices, 611 and 612 Electrical Exchange Building, Liberty street, and has taken up several contracts that were awaiting attention. A great many friends who appreciate Mr. Brown's good qualities welcome him back cordially to his wonted work.

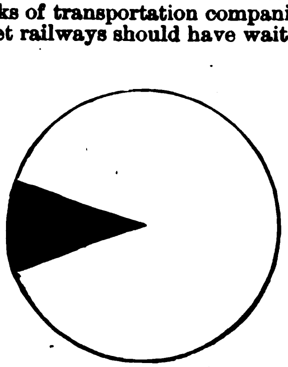
PROF. GEO. FORBES, F. R. S., of England, is shortly expected in this country on a visit combining business and pleasure; and his agent in New York makes a brief announcement on this subject in our columns this week. He is to arrive about April 9, and, as usual, will find his time fully occupied with social and professional engagements.

MR. LUCIUS T. GIBBS has recently been appointed electrical superintendent of the Milwaukee Street Railway. When the road is fully completed it will be one of the largest and best equipped in the country.

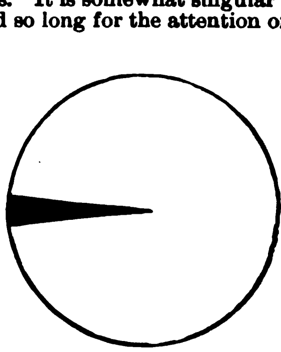
ELECTRIC AND STEAM RAILWAY NET EARNINGS.

THE Philadelphia *Stockholder* recently printed a diagram, which is here reproduced, representing the relative earnings of steam and street railways.

The entire circle, in each case, represents the capital invested. The shaded segments show the respective percentages of dividends on capital returned annually to the shareholders. An examination of the diagrams shows that the dividend segment of street railways is exactly three times as great as that of steam railways. This fact should interest those whose capital is invested in the stocks of transportation companies. It is somewhat singular that street railways should have waited so long for the attention of investors. As a general thing, hitherto, street railways have been owned by local capital, but now, with the coming of electrical operation and its high rate of net income, there seems every reason to believe that local capital everywhere will have to compete with much that has hitherto found its way to Wall street, for the acquisition there of steam road stocks and bonds.



STREET CAR DIVIDENDS.



STEAM ROAD DIVIDENDS.

Reports of Companies.

ANNUAL MEETING OF THE AMERICAN BELL TELEPHONE COMPANY.

THE annual meeting of the American Bell Telephone Company was held on March 29, in Boston.

The figures as to the number of instruments in service on Dec. 20, 1891—the close of the company's fiscal year—in comparison with the previous year, are:

INSTRUMENTS.	Dec. 20, 1891.	Dec. 20, 1890.
In the hands of licensees under rental	512,407	483,790
Increase over previous year	28,617	38,929

The report as to exchanges shows:

	1892.	1891.	Increase.
Exchanges	788	774	14
Branch offices	509	467	42
Miles of wire on poles	180,139	171,498	8,641
Miles of wire underground	70,334	54,690	15,644
Miles of wire on buildings	14,934	13,445	1,509
Miles of wire submarine	1,029	779	250
Total miles of wire	266,456	240,412	26,044
Total circuit	186,462	173,665	12,597
Total employees	8,376	7,845	531
Total stations	216,017	202,931	13,086
The estimated number of exchange connections daily in the United States, made up from actual count in most of the exchanges, is			1,584,712
Or a total per year exceeding			500,000,000

The number of daily calls per station varies in different exchanges from 2 to 16, the average throughout the United States being 7⅓, which shows an increase from last year in the average use made of the telephone by each subscriber of about 3½ per cent.

The average cost to the subscriber varies, according to the size of the exchange and character of the service, from less than 2 to 18 cents per connection.

The extra territorial lines at the present time, as compared with a year ago, show:

	Jan. 1, 1892.	Jan. 1, 1891.	Increase.
Miles of pole lines	41,298	35,541	5,757
Miles of wire	114,268	91,210	23,058

The extra-territorial connections during the year were:

Average number of connections	33,776
Or a yearly total of about	11,000,000

Reports received from the various companies operating exchanges and lines throughout the United States show a satisfactory growth of the business, and an activity, which was never more marked than at present, in making extensions and improvements of plant of such character as to ensure the best results in the way of effective and uninterrupted service.

A steady increase is recorded year by year in the number of connections required daily, by each subscriber, with other stations of his exchange, taking for comparison the successive averages of such calls throughout the country. The fact that this average of use has increased 35 per cent. within the last six years is an indication of the constantly growing value which the subscriber finds in the service of the telephone system.

While the net gain of 13,086 subscribers during 1891 is somewhat less than that of the preceding year, which is due in some measure to the severe and destructive sleet storms which visited several States in the early months of the year, it is still well above the average of the past seven years, and a large part of the increase represents subscribers for metallic circuit stations. With the advantages which this class of service affords, especially in places where trouble is experienced from the interference of strong electric currents, a largely extended use of this system is to be looked for in the near future.

As is shown in the usual table of exchange statistics, more than half of the increased mileage of exchange wire is in the form of underground conductors. There are now in operation 70,000 miles of underground wire, which is more than one-fourth of the entire exchange mileage in the country. While the use of this class of construction will, of necessity, be restricted, in the main, to the closely built sections of the larger cities, considerable extensions of the system are in progress, and the work of laying conduits and underground cable will this year be undertaken in several additional exchanges.

The entire expenditure during 1891, reported by licensees, for new lines and equipment was	$4,347,317 35
And for cost of land and buildings	800,793 93

The construction work of the American Telephone and Telegraph Company, in the completion and extension of its system, has included the building of a pole line from Pittsburgh to Harrisburg, and of a pole line from Altoona to Hazleton, and also a line westward from Pittsburgh to Cleveland by the way of New Castle. There have also been strung 10 additional wires on the lines between New York and Philadelphia and at various points minor additions of wire have been made to meet the growing demands of the business.

The total construction amounted to 463 miles of pole line; 4,942 miles of wire.

It is the intention, during the course of the current year, to fill the gap between Cleveland, Ohio, and Hammond, Ill., which last-named place is already connected by the long-distance lines with Chicago; thus giving through service between Boston, New York and Chicago. The report gives a brief summary of the litigation over the Berliner transmitter, and notes the decision given in favor of the Bell Company, last October. The present status of the cases of the Government and Western Union people against the company is detailed, and the report concludes with a statement as to the growth of and the valuable additions to the electrical department during the year.

Treasurer W. R. Driver in his report gives the ledger balances of the company as of December 31, 1891, in comparison with the previous year as below:

ASSETS.

	1891.	1890.	Inc.
Telephones	$979,117	$919,275	$59,842
Real estate	933,131	744,333	188,798
Stocks	33,180,409	32,740,580	439,829
Merchandise and machinery	8,885	8,933	*1,048
Bills and accounts receivable	3,192,918	2,034,280	1,158,638
Cash and deposits	655,823	187,935	467,888
Total	$38,950,278	$36,636,336	$2,313,942

LIABILITIES.

	1891.	1890.	Inc.
Capital stock	$15,000,000	$12,500,000	$2,500,000
Debenture bonds, 1888	2,000,000	2,000,000	....
Bills and accounts payable†	*843,909	1,334,636	*485,727
Patent account, profit and loss	10,274,913	10,516,545	*241,632
Profit and loss	5,688,567	5,645,131	43,436
Reserve	2,986,877	2,489,012	497,865
Surplus	2,151,012	2,151,012	... ...
Total	$38,950,278	$36,636,336	$2,313,942

The earnings and expenses have been as follows:

EARNINGS.

	1891.	1890.	Inc.
Rental of telephones	$3,127,783	$2,913,369	$214,414
Dividends	1,320,646	1,256,274	64,372
Extra territorial and branch lines commission	91,281	89,478	1,803
Telegraph commission	27,845	26,492	1,353
Interest	145,159	77,448	67,711
Miscellaneous	6,966	12,230	*5,264
Real estate	16,287	....	16,287
Total	$4,736,007	$4,375,291	$360,716

EXPENSES.

	1891.	1890.	Inc.
Expense of operation	$332,996	$311,438	$21,558
Legal expenses	74,604	123,359	*48,755
Real estate	29,068	....	29,080
Interest and taxes	309,110	257,175	51,935
Commission	614,019	575,221	38,798
Royalty	10,000	10,000	....
Concessions	239,396	228,574	10,822
Miscellaneous	....	106	*106
Total	$1,609,187	$1,505,873	$103,314
Total earnings	4,736,007	4,375,291	360,716
Total expenses	1,609,187	1,505,873	103,314
Net	$3,126,820	$2,869,418	$257,402

Surplus account Dec. 31, 1890	$2,151,012	(1889)	$2,151,012
Total net earnings, 1891	$5,277,832		$5,020,430
Dividends	1,725,000		1,463,918
Extra dividend	900,000		750,000
Res. for general depreciation	400,000		600,000
Res. for depreciation of instruments	101,820		55,000
Total disbursements	$3,126,820		$2,869,418
Surplus Dec. 31, 1891	2,151,012	(1890)	2,151,012

*Decrease.

†Of this amount $450,000 represents the dividend of Jan. 15, 1892, and $375,000 that of Jan. 15, 1891.

The report was accepted and approved by the stockholders.

The old board of directors was also unanimously re-elected. Their names follow: Thomas B. Bailey, Francis Blake, Charles P. Bowditch, George L. Bradley, Alex. Cochrane, William H. Forbes, Henry S. Howe, Charles Eustis Hubbard, Gardiner G. Hubbard, John E. Hudson, Charles E. Perkins, Thomas Sanders.

Two motions were then offered with the understood recommendation of the board of directors. The first was that the capital stock should be increased from $15,000,000 to $17,500,000, and the second that the new stock should be issued in the proportion of one new share for each six of the old now held. Both motions were carried unanimously. The meeting then adjourned.

COMMERCIAL CABLE COMPANY.

THE COMMERCIAL CABLE CO. has re-elected its old directors, J. G. Bennett, A. B. Chandler, George S. Coe, C. R. Hosmer, G. G. Howland, R. Irvin, Jr., J. W. Mackay, J. W. Mackay, Jr., E. C. Platt, T. Skinner, Sir D. A. Smith, W. C. Van Horne and G. G. Ward.

The year's earnings were $1,904,717.01, and expenses $819,-

392.43, leaving $1,085.324.58 profit. Dividends of 7 per cent. have been declared on $7,716,000 capital. The balance of the year's profits has been transferred to the reserve fund.

WESTERN UNION QUARTERLY REPORT.

The Western Union Telegraph Co. has declared a quarterly dividend of 1¼ per cent: for the April quarter.

The following statement exhibits the condition of the company at the close of the quarter ended December 31, 1891:

Surplus October 1, 1891, as per last Quarterly Report		$12,269,190 81
Net revenues, quarter ended December 31, 1891		1,907,166 66
		$14,176,356 97
From which deducting for—		
Dividend of 1¼ per cent. paid January 15	$1,077,408 81	
Interest on bonded debt	222,331 05	
Sinking funds	20,000 00	
		1,319,739 86
Left a surplus January 1, 1892, of		$12,856,617 11
The net revenues of the quarter ending March 31st, based upon nearly completed returns for January, partial returns for February, and estimating the business for March, will be about		$1,550,000 00
Add surplus January 1, as above		12,856,617 11
		$14,406,617 11
From which appropriating for—		
Interest on bonds	$222,330 00	
Sinking funds	20,000 00	
		242,330 00
Leaves a balance of		$14,164,287 11
It requires for a dividend of 1¼ per cent. on the capital stock		1,077,408 11
Deducting which, leaves a surplus, after paying dividend, of		$13,086,879 00

THE SHORT ELECTRIC RAILWAY COMPANY.

The annual meeting of the stockholders of the Short Electric Railway Company and the usual directors' meeting following were held at the office of the company on March 16. The following directors were elected: Sidney H. Short, Myron T. Herrick, J. Potter, John S. Bartlett, James Parmelee, Eugene Griffin and William B. Bolton. The directors met and elected the following officers for the ensuing year: J. Potter, president; S. H. Short, vice-president and chief electrician; Charles B. Lothrop, secretary and treasurer; E E. Higgins, general manager; William B. Bolton, general counsel. Mr. S. H. Short, who has been from the organization of the company its president and chief electrician, was renominated for the presidency, but declined to accept the position. He stated that owing to the growth of the company its duties had now become so onerous as to seriously interfere with his technical work and inventions, to which he desired to give his undivided attention, He therefore asked relief from his general business cares.

ELECTRIC LIGHTING AND POWER AT THE WORLD'S FAIR.

The Committee on Grounds and Buildings has decided to burn fuel oil on the Exposition grounds for running the power plant, instead of coal. This oil will cost 72½ cents per barrel of forty-two gallons. It is estimated that nearly 200,000 barrels will be used.

The question of electric arc lighting in the Exposition grounds has been decided by the Committee on Grounds and Buildings, who voted that the 5,000 or 6,000 lights required shall be secured at $20 per lamp, for 18 months' use of the apparatus. The Thomson-Houston Company, which in its bid asked $38.50 per lamp, lowered its price to $20. For that consideration it was given 3,500 lights. One thousand lamps were given to the Standard Electric Company of Chicago, and the remaining lights are to be furnished by other concerns. It seems likely that the plant for electric motor service will be put in by the Eddy Electric Manufacturing Company at $2.50 per horse power for 1,000 or 1,500 h. p. Possibly the Mather Company may do part.

Mr. A. C. F. Webb, of Sydney, New South Wales, has been appointed instructor in electrical engineering for the evening classes at the Sydney Technical College, and has begun his work. Mr. Webb has contributed to The Electrical Engineer, and is connected with the Postal Telegraphs. He is the son of Mr. H. H. Webb, secretary of the English Institution of Electrical Engineers.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 22, 1892.

Alarms and Signals:—

Electric Railway Signal, E. C. Wiley, 471,230. Filed June 18, 1891.

Consists of a base plate, two leaf springs secured thereto at their inner ends, and a double inclined depressible bar supported at its outer end upon the ends of the leaf spring.

Electric Signal for Railways, E. T. Turney, 471,296. Filed Nov. 10, 1890.

Provides means for signaling from one train to another in the front or rear and on the same track for the purpose of preventing collisions.

Boiler Feed Alarm, P. Kerekes, 471,311. Filed March 18, 1891.

Apparatus for Electric Railway Signaling, A. J. Wilson, 471,409. Filed May 23, 1891.

An electric block signal system for electric railways.

Electric Railway Signaling Apparatus, A. J. Wilson, 471,410. Filed June 15, 1891.

Similar in its object to No. 471,409.

Conductors, Conduits and Insulators:—

Safety Device for Electrical Conductors, J. Marx, 471,302. Filed July 6, 1891.

Claim:

The combination of a receptacle, electrical terminals included therein at a distance from each other and a compound in said receptacle of low resistance which becomes less conductive or non-conductive upon increase of temperature, and which connects said terminals.

Dynamos and Motors:—

Alternating Current Motor, E. Thomson, 471,155. Filed Aug. 17, 1891.

Claim 1 follows:

An alternating current motor comprising an armature and field coils inductively acting on said armature and connected to a single supply circuit, and a condenser shunting some of such field coils, whereby they are caused to lag behind the other coils in magnetic changes.

Lamps and Appurtenances:—

Carbon Holder for Arc Lamps, C. A. Pfluger, 471,190. Filed Oct. 17, 1890.

Employs a single carbon at one electrode and two or more distinct carbon at the other.

Electric Arc Lamp, H. Dewar, 471,234. Filed Sept. 15, 1891.

Consists in so adjusting the relations of the current passing through the lamp to the main and secondary magnet, etc., that the arc between the carbons is regulated and maintained under wide differences of amperage.

Disc Carbon for Arc Lamps, H. W. Libbey, 471,526. Filed Oct. 17, 1890.

Claim 4 follows:

A disc carbon having a groove or grooves on one or both sides whereby the amount of carbon consumed is regulated so that the carbon will burn equally all round.

Metal-Working:—

Electrically Welding Metals, A. De Meritens, 471,242. Filed Nov. 8, 1887.

Consists of applying at the points of junction of the metals to be welded an arc of sufficient power to fuse the metals to the required extent.

Miscellaneous:—

Wire Clamping Device, O. P. Briggs, 471,096. Filed Sept. 12, 1891.

Electrically Controlled Elevator, A. M. Coyle, 471,100. Filed May 28, 1891.

An arrangement for controlling the movements of an elevator from the different floors of a building.

Thermostatic Instrument, M. Martin, 471,130. Filed June 8, 1891.

Claim 4 follows:

In a thermostatic instrument, the combination with an active member consisting of a metallic ring of hollow terminal connections located on the opposite faces of said ring and bands or loops of fusible material encircling the said ring and joining the terminal connections thereto.

Electric Striking Mechanism for Clocks, S. C. Dickinson, 471,210. Filed Sept. 17, 1891.

Machine for Casting Grids for Secondary Batteries, A. F. Madden, 471,587. Filed July 24, 1890.

Claim 1 follows:

The combination, with a crucible, of the chamber communicating with the crucible, the mold at the top of the chamber and adapted to be moved across the latter, and the grate bars arranged at the upper end of the chamber and having their upper faces contiguous to the bottom face of the mold plate.

Railways and Appliances:—

Trolley-Wire Support, E. A. Sperry, 471,151. Filed July 9, 1891,

A trolley-wire support especially adapted to mining work.

Trolley-Pole Catcher, M. M. Wood, 471,206. Filed June 4, 1891.

Has for its object to provide means whereby the motion of the car may be utilized to bring down the trolley catcher.

Conduit for Electric Railways, F. O. Blackwell, 471,375. Filed Nov. 8, 1890.

Employs slot rails and transverse yokes placed at intervals overhanging at their upper ends the air space in the conduit, and having an opening in the overhanging portion for the removal of the insulators.

Charging-Table for Electric Railways, E. P. Usher, 471,447. Filed Aug. 31 1891.

Trolley-Wire Hanger, T. J. McTighe, 471,491. Filed July 11, 1891.

Comprises a metal plate adapted to be folded about the wire and having at its meeting point one or more registering tongues and slots forming a keyway.

Automatic Electric Block System, J. A. Carlton and H. L. Johnston, 471,525. Filed June 16, 1891.

Switches and Cut-Outs:—

Vibrating Electric Switch, J. S. Gibbs, 471,237. Filed July 3, 1891.

A switch in which the throw shall be great in comparison with range of movement of the device causing it.

Electric Switch, A. Metzger, 471,271. Filed June 6, 1891.

A jack-knife switch that shall be strong and simple of construction.

Telephones and Apparatus:—

Long-Distance Telephone System, E. Gwozdeff, 471,310. Filed Feb. 15, 1889.

Employs michrophones and telephones connected with the line by means of the separated condensers, and connected with a return line by means of condensers the capacity of which corresponds with the respective resistances of the two lines.

Telephone System, A. B. Ferdinand, 471,352. Filed June 29, 1891.

Provides means for preventing a subscriber from interfering with another while his telephone is in circuit.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

"Ads" are good guy wires for the circuits of trade.

MR. W. A. ROSENBAUM.

W. A. Rosenbaum.

THE development of the electrical patent business in New York city has been rapid of late years, and has given opportunities to young men of ability to make reputation and standing in a new field. Among those who have come to the front is Mr. W. A. Rosenbaum, who for some five years past has conducted the patent agency of the W. J. Johnston Co., Ltd., and who now is starting out for himself. The concern referred to is abandoning its agency, and Mr. Rosenbaum takes over the clients, library, etc., of that part of its business. Mr. Rosenbaum, whose portrait we give here in vignette, has long been engaged in patent soliciting, and one of his earliest pieces of work was taking out all the patents relating to the cable road on the Brooklyn Bridge. He has taken out a great many electrical patents, and is familiar with all branches of the industry, both as solicitor and as expert. He will occupy his old offices in the *Times* Building, this city, and will carry on a patent agency in all its departments. Freed from hampering influences, Mr. Rosenbaum may safely expect to enjoy a large share of patent work, especially in the branch with which he has so long been identified.

WESTINGHOUSE ROADS FOR NEW ENGLAND.

MR. R. S. BROWN, electric railway representative of the Westinghouse Co., reports to us the closing of one or two important contracts through the Boston office. The Fitchburg & Leominster Street Railway Co. has contracted for eight car equipments of the single-reduction type, each with two motors of 20 h. p., with one 100 h. p. generator and one 150. There will be 13 miles of track. The road is now operated by horses, but it is hoped to have the first part of the new system running by May 20. The generator will be run by engines of the Fitchburg Steam Engine Co.

The other recent contract is for the first gearless equipment in New England. Mr. Amos F. Gerald has ordered for the Waterville & Fairfield, Me., Street Railway Co. an outfit of six gearless motor cars, each with two motors. The current is to be supplied by 150 h. p of generators. Mr. Gerald is a well-known mechanician, and under his enthusiastic management the road is expected to be an exemplar of efficiency and success.

ELECTRICAL ACTIVITY AT DUBUQUE, IA.

THE DUBUQUE STREET RAILWAY CO., after a year's experience with storage cars, have decided to change to the overhead system. The Edison people will do all the line and station work. The Detroit Electrical Works will equip each car with one 40 h. p. double-reduction motors of the Rae type. The station being centrally located will prove a great saver of copper, and will be furnished with two No. 20 Edison dynamos, operated by a Sioux City Corliss engine, rated at 125 h. p. The car bodies now fitted for storage batteries will be used in addition to ten more from the St. Louis Car Co. Side-pole construction will be used with wooden poles on all lines but Main street, where Walworth iron is required under the franchise. The Edison Co. now have a crew of men on the ground doing good work, under the supervision of the city electrician and subject to his approval.

The United States Electric Light and Power Co. are receiving material for their line work. They have contracted to furnish "Standard 2,000 c. p. arc lights according to Philadelphia moonlight schedule, also on all dark and cloudy nights, for $64.95." The contract runs for three years, number of lights 200. Dividends at that price will neither be large nor frequently declared.

The Dubuque Electric Light and Power Co. are quietly holding their own, and appear to be doing all there is to be done along their route.

The Key City Electric Railway Co., who climb a grade varying from one to nearly nine per cent. for the greater portion of their trackage, about two miles, are now in the hands of a receiver and may be ordered sold at any time.

The Central Union Telephone Co. are about to place aerial cables over the portion of the city near their office.

THE SHAW ELECTRIC CRANE CO.

THE above company of Muskegon, Mich., has been extremely busy of late, to such an extent that an increase of facilities is becoming necessary in order to keep pace with orders. Among the contracts recently received are one each of 5, 10 and 20 ton cranes, for the Pittsburgh Iron & Steel Engineering Co., to be used in the new Carbon Iron Company's plate mill which they are building; one 80-ton double trolley and one 20-ton single trolley for the Midvale Steel Co.; one 20-ton crane for the Dry Dock Engine Works, Detroit; one 10-ton for the Taylor Iron & Steel Co., and one 15-ton electric jib crane for the Congdon Brake Shoe Co., Chicago. The works are now running night and day.

IMPROVEMENTS AT RICHMOND SPRINGS, N. Y.

THE ELECTRIC LIGHT AND POWER COMPANY contemplate remodeling their plant. More machines will be added, or else those in present use will be replaced by larger units worked from a compound condensing engine.

Mr. Allen Bloomfield is president, and Mr. James A. Stover, the manager of the company.

ST. NICHOLAS HOTEL, CINCINNATI, O.

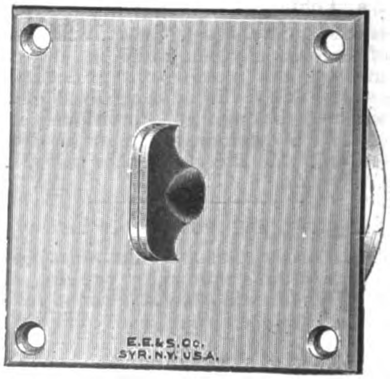
THE steam and electric lighting plant of the St. Nicholas Hotel is considered one of the best and most complete in Cincinnati. A portion of the equipment consists of a 300 h. p. battery of Root water tube boilers. The manufacturers, Messrs. Abendroth & Root Manufacturing Company, New York, report a steady demand for their specialty from the West.

UNIVERSAL RADIAL DRILL CO.

THE calendar for March, issued by the Universal Radial Drill Company, of Cincinnati, Ohio, contains a talk on suspension drills and is accompanied by an illustration showing type No. 1 of the company's manufacture.

THE FLUSH SWITCH.

THE ELECTRIC ENGINEERING AND SUPPLY CO., of Syracuse, N. Y., have recently introduced the switch shown in the accompanying illustration. This device, as its name implies, is let into the wall, its face being flush with the surface, where it attracts but little attention. The manufacturers consider this switch a step in advance of anything heretofore used for this purpose.



THE FLUSH SWITCH.

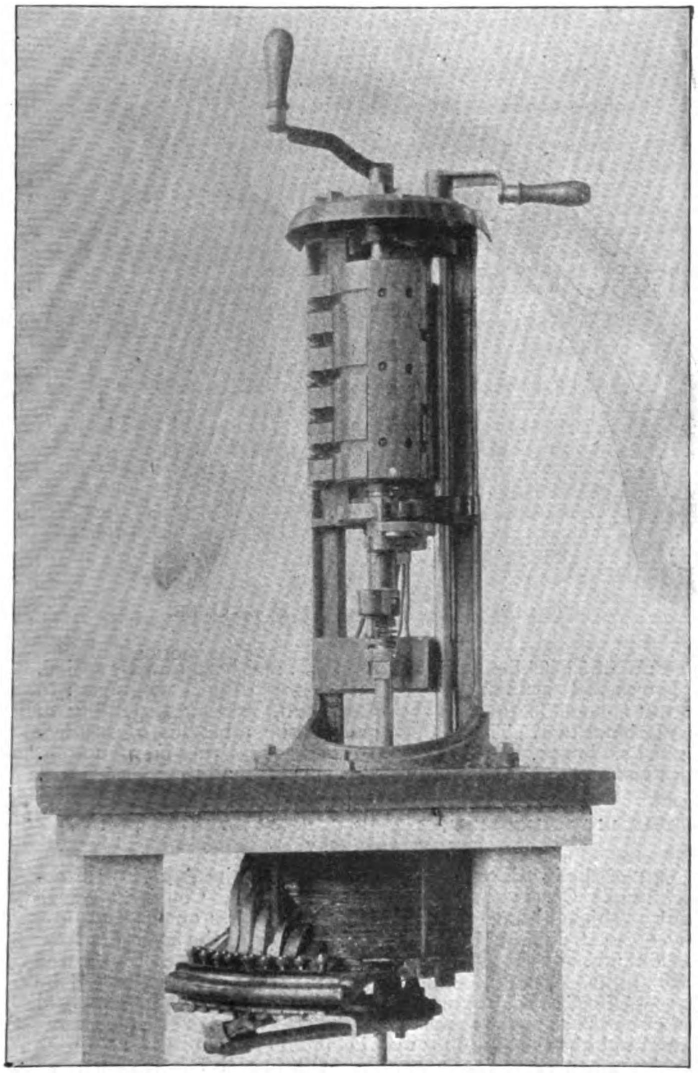
W. A. GILES, 416 Lewis Block, Pittsburgh, will handle McIntosh & Seymour, Porter and Case high-speed automatic engines, Goubert's feed-water heaters and Stratton separators, also Wing's ventilating apparatus, in this territory. Mr. Giles is favorably known as a contracting electrical and mechanical engineer.

PUNXSUTAWNEY, PA.—Some persons have just obtained a charter for an electric road in this town, with James K. North as president. The capital stock is $18,000. It is understood that no arrangements or contracts have yet been entered into by the company for the equipment of its road.

THE EDISON RAILWAY CONTROLLING SWITCH.

The Edison General Electric Company have recently devised a new type of street car controlling switch shown in the accompanying illustration, intended to take the place of the present platform switch for equipments of large motors of 25 h. p. and upwards.

In starting the car the switch-handle is turned from the position marked "off" with a "counter clockwise" movement, which has the effect of carrying the arm of the rheostat placed under the switch around on its contact segments and the resistance is gradually cut out of circuit. After this arm has been carried around and all the resistance cut out, it is released from the cylinder shaft and left locked in this position. Further movement of the handle then affects only the cylinder, and commutates the field magnet coils of the motors from series to parallel in the usual way.



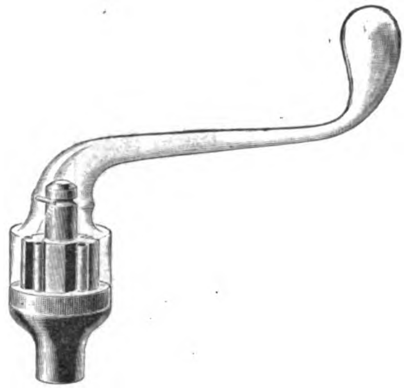
The Edison Railway Controlling Switch.

In stopping, the field coils are turned from parallel to series, the resistance coil is then again put in circuit and finally the circuit is broken by the contact lever on the last segment of the resistance coil, and not, as formerly, upon the cylinder contacts. The only caution to be observed in stopping is to see that the switch-handle is turned to the position marked "off." As the motors are reversed by means of a separate lever operating a reversing switch placed under the car, the reversing lever is connected to a shaft separated from the cylinder shaft, but interlocking with it in such a manner that it is impossible to reverse the motors until the cylinder shaft is in an "off" position. The cylinder plates and contacts are made of thick iron stampings, as experience has shown that iron is a better material to use than brass, hitherto employed. Sparking does not burn the iron as much as the brass, and greater certainty of good contact is insured. The rheostat is of the regular circular pattern resistance coil. This rheostat is protected by a galvanized iron case. The current from the trolley wire first goes through the field coils and switch cylinder for commutation, then through the armature and reversing switch, and thence through the switch contact lever and resistance coil to ground.

Only six wires are run to the platform switch; these are the field magnet wires. The three wires running to the reversing switch are of the same size as the regular armature wires, as is the wire between the metal terminal of the reversing switch and the contact lever of the rheostat. When fitting switches to cars already wired, the cables can be utilized, but the terminals of the wires left idle should be well insulated.

THE LYON BRAKE HANDLE.

We illustrate in the accompanying engraving the new Lyon brake handle which is being introduced by the Consolidated Electric Manufacturing Company, of Boston. As is well known from experience, the ordinary ratchet brake has a very short life in actual service, owing to the constant use to which it is put, wearing out the teeth and the dogs, the parts on which there is most strain. The renewal of these parts is a constant expense to the railroad company and a source of considerable revenue to the manufacturer. The Lyon brake handle is constructed in a novel manner. A series of steel rollers is placed in a V-shaped recess between the steel barrel of the handle and the head of the brake rod. It is therefore ball-bearing and noiseless in one direction, but immediately grips when the handle is pulled the other way, there being nothing stronger than a leverage of this kind. Repeated trials have been made by different roads, and the Consolidated Electric Company have received many letters and orders on account of these successful tests. They will be pleased to send samples of this brake to any road desiring to test it, and invite comparison.



The Lyon Brake Handle.

THE H. W. JOHNS MANUFACTURING COMPANY.

A very neat catalogue has been issued by the above company, of 87 Maiden Lane, this city, describing their asbestos materials for roofing and building steam pipe covering, packing, fireproof cement, etc., as well as various asbestos fabrics of their manufacture.

Vulcabeston, a compound of asbestos, india-rubber and other vulcanizable gums, manufactured by the Johns-Pratt Company of Hartford, Conn., is made up into insulating rings and washers, commutator heads, incandescent lamp bases and keys, arc lamp carbon holders and many other similar devices, and has given great satisfaction.

SIEMENS & HALSKE CO.

The above company has recently organized its American branch in Chicago with O. W. Meysenberg as president; A. W. Wright, secretary; directors, Arnold von Siemens, G. W. von Siemens, O. W. Meysenberg, A. Wright and A. von Babo. The last named has for some time past represented the Siemens & Halske interests in this country, and still carries on their office in the *Times* building in this city. We are informed on the best authority that the German house has paid in its proportion of the capital with which the new enterprise is to start.

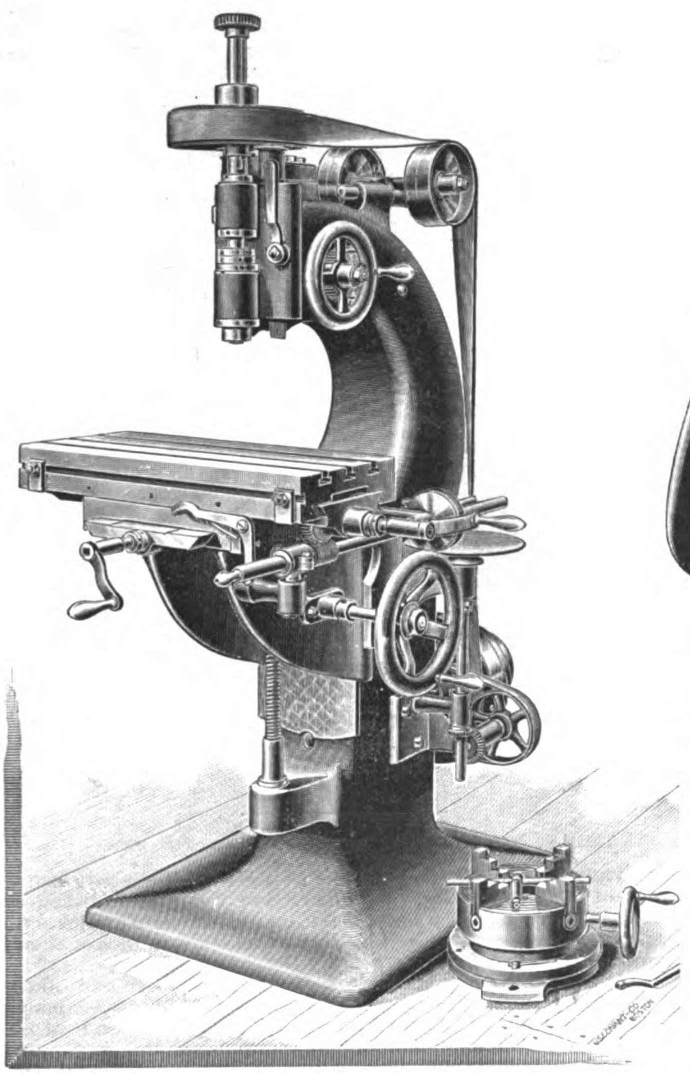
Col. G. L. Austin has merged *The Electric Railway Advertiser* in a monthly paper which he calls *Electricity and Railroading*, which will appear as a monthly devoted to the interests set forth in its title.

THE BECKER VERTICAL MILLING MACHINE.

We illustrate on this page a new vertical milling machine brought out by the John Becker Mfg. Co., of 157 Pearl street, Fitchburg, Mass., who have been making a specialty of such apparatus for electrical factories.

The belt thrust in this machine is taken upon a bearing which rests upon rollers, reducing the friction to an inconsiderable amount, while at the same time it relieves the spindle of all side pull caused by the belt. The spindle is mounted in a saddle, which is moved up or down by hand wheel shown at the right, and can be clamped by the lever seen in front. Milling tools are held in place by a threaded rod, which passes through the hollow spindle, making it easy to secure or remove them. The spindle is made of tool steel, hardened and ground to insure accuracy.

The platen has an automatic feed, which is automatically released at any desired point when moving in either direction, and the different rates of feed are obtained by means of a friction disc and roll, which latter can be placed any desired distance from the centre either side, for feeding at any desired rate in either direction. Adjustable stop gauges are provided for all movements for convenience in duplicating work. The lateral feed of table is 16 inches; cross-feed (in and out from the column) 11 inches; vertical adjustment of knee, 15¼ inches.

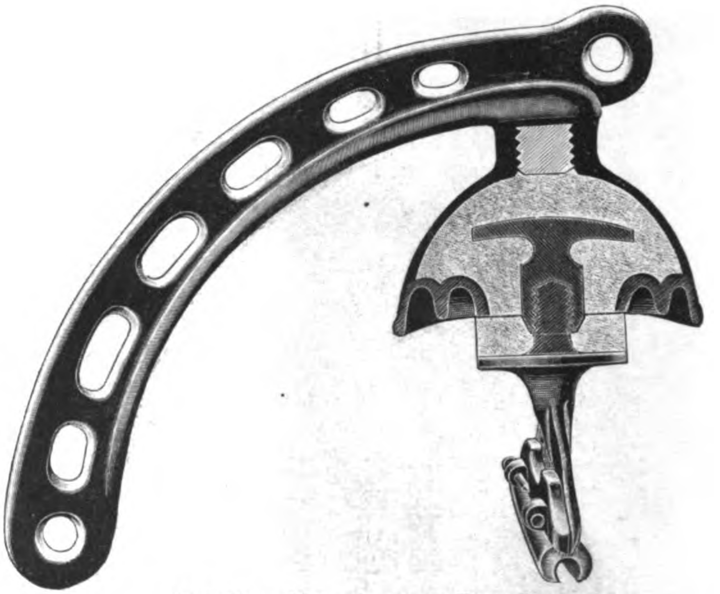


THE BECKER VERTICAL MILLING MACHINE.

There is also furnished when desired the rotary attachment shown on the floor at the side of the machine, this being provided with a 9-inch chuck, in which work may be secured and rotated by means of a worm and hand-wheel as shown. This, of course, will be found very useful for a large class of work, and any desired fixture may be fastened to the platen, T slots being provided for that purpose. Special pains have been taken to have all hand-wheels placed in the most convenient position for the operator, so that the machine may be handled with the greatest possible facility. The greatest distance from the platen to the spindle is 15¾ inches, and the machine weighs complete, ready for boxing, 1,500 pounds.

THE NEW MICA ASBETITE PULL-OVER.

OUR attention has been drawn during the past few days to the railway specialties manufactured by the Mica Asbetite Insulating Company, of 444 Pearl street, New York City. One of their specialties is an entirely new style of pull-over, of which the accompanying illustration is an excellent reproduction. As can be seen in the engraving, the device has a "bail," the upper end of which has a ⅝-inch shank which screws into the top of the bell. The bail, when desired, is made continuous, *i. e.*, to pass over to the other side, and in many cases the small hole at the upper end is convenient, when necessary to continue the span-wire. A collar on the clamp-shank when screwed up presses against the insulated disc at the bottom of the bell, making an exceedingly substantial pull-over, neat and strong and very light. The curved clamp is 3 inches long, and is curved to a radius of 26 feet. The bell used in the above pull-over is manufactured by this company and consists of a light malleable iron shell filled with their famous "Asbetite" insulating compound, forced into the shell under a pressure of 56,000 lbs. to the square inch, and hermetically sealed. This material is unaffected by any degree of heat whatever; in fact, it is possible to melt the entire shell, leaving the filling of insulation intact. The company also make all styles of insulating bells, clamps, hangers, etc., for electric railway construction. They issue a neat catalogue, which they will mail to all desiring it.



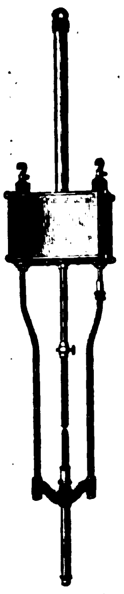
THE NEW MICA ASBETITE PULL-OVER.

THE LIGHTING OF THE ERIE COUNTY SAVINGS BANK, BUFFALO, N. Y.

ONE of the last large contracts secured by the American Electric Supply Co. is that for lighting the Erie County Savings Bank. This building when finished will possess one of the most perfect isolated plants in the country, and one of the largest in New York State, outside of New York City. The contract calls for 1,500 lights. The dynamos to generate the electricity will be three of the C. & C. Company's manufacture; two of 40,000 watts, and one of 20,000 watts capacity. A better idea of the power required to light the building may be obtained when it is said that the American Electric Supply Co. will install for this purpose three Straight Line engines, made by the Straight Line Engine Co., of Syracuse, N. Y., two to be of 60 and one of 30 h. p. The wires throughout the building will be run in conduit, manufactured by the Interior Conduit & Insulation Co. of New York City, and for which the American Electric Supply Co. are agents. Buffalonians generally will be interested in watching the progress of this work. The above work has been done under the personal supervision of the general manager, Mr. W. A. Fenn.

The American Electric Supply Co. has become well and favorably known during the single year of its incorporation. It has grown with the increased demand for electricity as a means of lighting, and for all electrical appliances of all descriptions, till to-day it stands among the leading electrical supply houses of the country. Two thousand incandescent lights are a good many, yet the company has installed that number in the Cornell University Building, including one thousand in its fine new library, and five hundred in Sage College. Regarding the Sage College plant, the New York State inspector remarked that it is the best piece of work he has ever inspected. The Law Building, in course of construction, will add 500 more to the credit of the "Supply Co."

THE HEYMANN ARC LAMP FOR INCANDESCENT CIRCUITS.



Heymann Arc Lamp.

There is at present a great demand for a good reliable arc lamp for use on incandescent circuits, and we therefore illustrate in the accompanying engraving the latest production in this line, the "Heymann" arc lamp, which is claimed to possess many new features of peculiar excellence. The Heymann lamp is purely an electric feed arc lamp, having no clockwork, gearing, racks or pinion, no solenoids nor magnetic rods, the current simply and accurately feeding the carbon downwards as it is consumed. It is a marvel of simplicity, and as there is no chance for wearing out, the parts never need renewing. The Heymann lamp requires 45 volts pressure, but will burn in series on any voltage, a suitable resistance being provided to compensate for the difference. The lamp is manufactured by the Consolidated Electric Manufacturing Company, of Boston, who will be glad to send samples to any responsible party on trial for their approbation.

TRACTION IN NEW ORLEANS.

The old franchise of the Crescent City Railroad Co., New Orleans, will be sold at auction this week, and there is a great probability of a conversion taking place from mules to electricity. It will be remembered that a long trial of storage cars was made in New Orleans, with poor results. The next time, the overhead system will be used.

A DECISION IN FAVOR OF THE STILWELL PATENT ON LIVE STEAM FEED-WATER PURIFIERS.

The U. S. Circuit Court for the Southern District of Ohio, Western Division, has just rendered a decision in favor of the Stilwell & Bierce Mf'g. Co. in a suit brought against S. N. Brown & Co. for infringement of patent No. 274,048 granted to E. R. Stilwell for feed-water heaters and purifiers. The infringing apparatus is what is known as the Hoppes purifier, made by the Hoppes Mf'g Co., of Springfield, O. The decision of Judge Sage sustains the Stilwell patent broadly.

PAINE & FRANCIS.

The news of the dissolution of this well-known old firm was first announced about a month ago, but as a matter of fact the step is only the result of what was begun in August, 1890, the firm being kept alive until this time for the purpose of complete liquidation. The firm was organized as far back as August 1885, but both members of it—Messrs Sidney B. Paine and W. H. Francis—had been active in the field several years prior to that, dating, indeed, as far back as 1881. Their active connection with Edison interests continued throughout, in various forms, and when their concern known as the New England Wiring & Construction Co. was bought out in August, 1890, by the Edison General Electric Co., they entered the employ of the latter corporation as manager and auditor, respectively, for the New England district.

QUEEN'S STANDARD PORTABLE TACHOMETERS.

Queen & Co., Philadelphia, are just placing on the market a new portable tachometer for instantly determining the speed of rotating shafts. Three spindles are geared to the rotating parts inside of the case, each one of them having a separate scale on the dial, so that the indications are direct reading throughout. A detachable point, with slightly flexible end, to fit any of the spindles, is supplied, the flexibility of which acts as a safeguard, for if made perfectly rigid there is danger of breakage when not applied exactly at right angles to the shaft.

A scale to correspond with each spindle, is graduated on the dial, and the ranges covered are: 40 to 200, 120 to 600, and 600 to 8,000, which gives a maximum capacity of 40 to 3,000 turns per minute. A conveniently shaped handle is attached to the body of the instrument so that it can easily be held in the hand.

The apparatus is well made and presents a handsome appearance, the different parts being nickel-plated.

A tachometer like this is very desirable for both expert and practical work, and those interested in the subject should write to the makers for a copy of circular No. 310.

J. H. **Siegrist, Jr.**, & Co., 313 Olive street, St. Louis, Mo., have just furnished the St. Louis and Suburban Railway Co. with one of the "Ideal" engines for their new power house.

NEW YORK NOTES.

F. P. **Little** & Co. of Buffalo, N. Y., have just closed a contract with the Connecting Terminal Railroad Co., of Buffalo, for installing a plant consisting of one 500-light Thomson-Houston dynamo, one 88 h. p. engine of the John T. Noye Manufacturing Company's make; 24 2,000 c. p. Mosher arc lamps, and 125 16 c. p. incandescent lamps, all equipped complete, ready to operate. They have also lately closed contract for wiring the Columbia Bank Building of Buffalo for incandescent lights. Business is very brisk with them at present. They are wiring the City Elevator for 300 incandescent lights and five arc lights, complete, with engine, dynamo, etc; the Bell Telephone Company's Building for 150 lights, and rewiring Weyand's Brewery for 125 lights, all of this city.

Wm. A. Mosscrop, M. E., who was formerly identified with the Edison Electric Light Co., and who for the last two years has been connected with electric railway interests, as engineer and superintendent of construction for the Woodbridge & Turner Engineering Co., has recently terminated his contract with that company and will hereafter make his headquarters with W. A. Day, M. E., 128 Oliver street, Boston. Mr. Mosscrop is to be congratulated upon entering into business relations with Mr. Day, whose agency in New England for the improved automatic engines made by the Ball & Wood Co., and whose general business in engines and boilers, and as an expert engineer has been so successful.

The Interior Conduit & Insulation Co. of 42 and 44 Broad street, New York, do not confine their operations to this country alone, as their foreign agents are placing large and satisfactory orders all the time. Mr. Everett Frazar, 124 Water street, New York, their agent for China and Japan, is shipping extensively to the above named countries. The Chinese and Japs are not behind the age, and evidently know a good thing when they see it.

The Clark Electric Co. have received a very handsome testimonial from Schwarzschild & Sulzberger, the big exporters of dressed beef, in this city, as to the efficiency of the Clark automatic safety device used on their high tension dynamo. Mr. Wm. Lewis, the chief engineer, says that he considers it a very important piece of apparatus and a valuable addition to the plant.

The Perkins Lamp.—An office has been opened at Room 114 Bennett Building, this city, by the Perkins Electric Lamp Co., for the sale of their lamps in connection with the Mather Electric Co.'s dynamos and motors.

West Troy, N. Y.—The electric light plant is to be improved and 50 new lamps are to be bought.

NEW ENGLAND NOTES.

The Beacon Vacuum Pump and Electrical Co., of Boston, are dealing in symbols—not tinkling, but striking. They are determined that electrical concerns shall use their Beacon lamp in one way or another, and so have issued a blotter in the form of an incandescent globe. It is of white material—indicative of the brilliancy of the lamp—and we are told the lasting powers of the blotter are only excelled by the long life of its prototype. No house interested in any way in electrical matters is complete without this incandescent blotter.

Albert and J. M. Anderson, of Boston, are out with a new catalogue, showing the various good points of their Ætna insulated line material for overhead railway construction. The cut on the back cover is worthy of notice, as it represents one of their insulators attached to the well-known tag of the Massachusetts Electrical Engineering Company, guaranteeing that they had tested the insulator and found an insulation of 156,000 ohms at a temperature of 70 degrees Fahr.

The Boston Electric Club will dine at Young's Hotel on Wednesday evening, April 6th, at 7.30 p. m., on which occasion Mr. William Stanley, Jr., will address the members upon "Some New Apparatus for Use with Alternate Currents." It is expected that there will be a large attendance, and Mr. Stanley's work in the development of alternate current apparatus is so well known that it goes without saying that a most profitable and interesting evening will be spent.

The Porter and Leavitt Manufacturing Company, of Providence, R. I., report that they have had remarkable success with their small motors, and are as busy as possible. They have had to increase their manufacturing facilities largely, owing to the rush of business, and have now a large and well-equipped factory. They have received many orders from foreign countries, many of them, it is gratifying to note, due to their advertisement in **The Electrical Engineer**.

The Freeman-Holland Company, of Boston, report that they have secured a contract from the Hull Electric Light and Power Company, of Hull, Mass., for two 1,500-light alternating generators, and 4,000-light capacity of transformers and lamps.

The New England Electric Club announces through its treasurer, Mr. A. O. Smith, that the directors have leased the premises of No. 14 Bosworth street, Boston, for four years, for the purposes of occupation as a club house. It is hoped that the rooms will be ready for occupation by the middle of April, and work will at once be commenced fitting up the billiard-room, parlor, reception, dining and other rooms.

Berlin Iron Bridge Co.—The new machine shop for the Henry R. Worthington Hydraulic Works at South Brooklyn, N. Y., will be built of iron by the Berlin Iron Bridge Co., of East Berlin, Conn. The building is 200 feet long by 50 feet wide with a 20-ton Sellers traveling crane. The building is made from the designs of the Berlin Company, who furnish it complete, including the foundations and the brick-work.

The Combination Car Company, of Boston, whose car was recently described in these columns, tendered a reception this week to the officials of the different street railways in the vicinity, for the purpose of introducing their combination car to notice. Many representative gentlemen were present, and a pleasant afternoon was spent, the general opinion being that the car had a great field of usefulness before it.

Mr. F. A. Magee, of 126 Pearl street, Boston, has been appointed New England agent for the Bishop Gutta-Percha Company, of New York, and will hereafter carry a large stockof the general sizes of this company's well-known high-class wire. Mr. Magee will continue to handle the Cleveland transformers, cut-outs and railway switches, as well as the Underwood belting and Dodge split pulleys

The Bridgeport Electric Light Company, of Bridgeport, Conn., are making arrangements to push the erection of their new station, and have bought a piece of ground facing the harbor 210 feet by 100 feet, where they will be able to secure plenty of water for condensing purposes.

The Union Electric Manufacturing Company, of Bridgeport, continue to flourish and are enjoying a good run on their specialties.

PHILADELPHIA NOTES.

Merchant & Co., the great metal dealers and specialists of this city, have long been noted for the clever uniquity of their advertising. It is they, for instance, who are entitled to the credit of first using Brownies in the advertising field, while many of their trade mark efforts are masterpieces. Mr. Malcomb Marvel, whoever he many be, has now written a very pithy and picturesque account of the concern entitled: "The Advertising History of a great House," and a reprint of it from *Business* is being used to good advantage.

Henry Brunt & Son, porcelain manufacturers, of East Liverpool, Ohio, have erected a large factory for the manufacture of hard porcelain for electrical purposes. They have a well equipped machine shop in connection, where dies are made for simple and intricate shapes. This plant has been established for years, and is favorably known as the Riverside Manufacturing Co. They go into this branch of their business with a determination to keep up their reputation as making first-class goods at a very reasonable figure.

Mr. T. J. Cope, 8 North 6th St., has been abundantly blessed with orders of late for the Cope "Automatic Come-Along" or "Wire-Puller," of which he is the inventor and sole manufacturer. These come-alongs possess several advantages, as is shown on another page of this paper.

Mr. T. L. Townsend, of the Partrick & Carter Co., has just returned from a very successful trip West. It was our good fortune to witness his taking several large orders in Pittsburgh and Allegheny last week, which would aggregate over $4,000.

W. C. McIntire & Co., of this city, are meeting with very gratifying results in the sales of their new "Crown" shade or reflector.

James J. Murray & Co., glass globe and shade manufacturers, report business brisk. They are at present working on orders from parties in Central and South America.

WESTERN NOTES.

The Sunbeam Incandescent Lamp Co. report that their factory is pushed with orders for Sunbeams, and they have done more business during the last month than any previous one. This speaks volumes for the favorable way in which their lamps are regarded by the public.

Mr. G. M. Angier, recently assistant manager of the Knapp Electrical Works, has resigned his position to accept a similar one with the Mather Electric Co. of Manchester, Conn. Mr. Angier will be missed by his many friends in Chicago, all of whom will wish him success in the East.

Mr. F. W. Cushing, general Western agent of Kerite insulated wire and cables, has fitted up his new suite of offices at No. 225 Dearborn street very handsomely, and has a most complete line of samples of all sorts and sizes of wire, and keeps on hand in his storeroom a large stock, enabling him to make very prompt shipments. Mr. Cushing is having framed some handsome pictures of twenty of the prominent electricians of the world, which he intends hanging on the walls of his private office, thus giving it a very unique and interesting feature. In line with the adornments for his office are Mr. Cushing's striking advertisements. in which he has shown the handsome full-page cuts of several of Chicago's large office buildings which are wired with Kerite. He is doing a large business already, and users of wire recognize the improvements which have recently been made in these wires and cables to fit them particularly for electric lighting and other work of the severest kind to which an insulated wire can be subjected.

Burton Electric Co.—The annual meeting of the Burton Electric Co. was held on March 23, at the offices of the company in Richmond, Va., and Mr. W. R. Mason, of Chicago, was re-elected to the position of president. The following resolution was unanimously adopted by the stock holders: "Resolved, That the stockholders of the Burton Electric Co. hereby tender to Mr. W. R. Mason their acknowledgments of their high appreciation of the efficient and successful manner in which he has conducted the affairs of the company during the past year and that the secretary be instructed to inform him of his unanimous re-election to the presidency for the ensuing year, with a copy of this resolution." This is a graceful tribute to Mr. Mason's well-known executive business ability, and his many friends will appreciate the compliment tendered him.

The Fort Wayne Electric Co. have fitted up their offices at 185 Dearborn street, which were entirely devastated by the recent fire, in a very handsome manner. The decorations are of the Moorish order and exceedingly striking, and the lighting, which is effected by means of bunches of incandescents in which opalescent shades are attached to the ceiling, is very beautiful. All the finishings and office furniture are of oak, and tiled flooring has been put in, and the appearance of their quarters is exceedingly attractive and business like. The lighting and decorative effects were devised by Mr. W. H. Harding, the manager of the Central Electric Light Co., who operate the Fort Wayne Electric Co.'s system in this city.

The Central Electric Company are preparing a house-goods catalogue, which they hope to have ready in April. The catalogue will be replete with cuts and descriptive matter of the latest designs in this department of their business. They are sending out a very handsome circular in reference to tested fuse wire and terminal fuses. The circular contains an article on fuse wire that was read before the Chicago Electric Club, December 7, 1891, by Mr. Elmer A. Sperry, and contains valuable information on this most important subject.

The Electrical Supply Co., Chicago, have secured the exclusive agency in the United States for the well-known and popular Boston trolley, manufactured by Albert & J. M. Anderson This trolley has met with very general adoption, and is a prime favorite. The Electrical Supply Co. feel that in this article as equipped with their Reedfeed trolley wheel hub they have a combination of many excellent features. They keep a full supply of parts on hand.

Mr. D. B. Dean, who for some time past has been connected with the Electric Mdse. Co. as selling representative, has resigned his position to take a similar one with the McGuire Mfg. Co. Mr. W. R. Mason, general manager of the Electric Mdse. Co., regrets the loss of Mr. Dean, as he has done excellent work in the past, and unites, with his many friends, in wishing him success in his new connection.

Detroit Electrical Works.—The Chicago office of the Detroit Electrical Works, which is now at 481 Rookery, will, after April 15, be in suite 917–918 Monadnock Building, corner Dearborn and Jackson streets. Mr. L. E. Myers, special agent of the company, is the manager of the Chicago office, and Mr. H. A. Kinney, well known in electrical circles, is now connected with this office.

The Electric Appliance Company report having closed arrangements with the New York and Ohio Company to handle the Packard lamp exclusively in Indiana and Lower Michigan, and have already commenced to lay plans for a large future lamp business in this territory. The Appliance Company are also pushing the sale of "Canvas Jacket" wire and of the "Flexible Conduit."

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XIII. APRIL 13, 1892. No. 206.

NOTES ON THE DETERMINATION OF WIRE FOR MULTIPLE ARC DISTRIBUTION.

BY

J. Lester Woodbridge

THE problems which the electrical engineer encounters in laying out a system of conductors for electrical distribution are among the most important, and often the most intricate, that he is called upon to solve. They are, as a rule, capable of exact mathematical solution, when the conditions are known, yet we too often see them dismissed with a more or less approximate guess at the result, or with a "rule-of-thumb" method of solution, both of which frequently hit very wide of the mark. Some of those problems have already been discussed in these columns, and have evoked a very general interest in the subjects treated. I do not propose, however, to review, in any sense, the subject of "electrical determinations," so called, but would call attention to a few points that are frequently met with.

To lead up to them, consider first an elementary arrangement shown in diagram Fig. 1. In this diagram I have represented the central station at S, and the points where the current is to be applied at A, B, C, D, etc. As the problem is usually presented, we have a given loss which must not be exceeded at any point in the system of conductors.

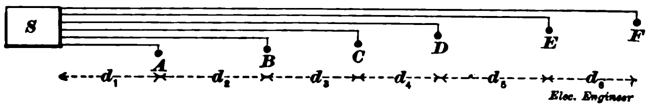


FIG. 1.

If the wiring is arranged as in Fig. 1, (which represents only one side of the system, the return wires being omitted), the calculation is very simple, each wire being determined by the well-known formula,

$$\text{cir. mils} = \frac{10.5 \times \text{amperes} \times \text{feet}}{\text{volts drop}};$$

and if V is the given maximum drops in volts; $a_1\ a_2\ a_3$, etc., the current in amperes carried by SA, SB, SC, etc., respectively; $(c.\,m.)_{A}$, $(c.\,m.)_{B}$, $(c.\,m.)_{C}$, etc., the circular millage of the respective wires; d_1, d_2, d_3, etc., the distance in feet between S and A, A and B, B and C, etc., respectively; we have,

$$(c.\,m.)_{A} = \frac{10.5\ a_1\ d_1}{V};\ (c.\,m.)_{B} = \frac{10.5\ a_2\ (d_1 + d_2)}{V}, \text{ etc.} \quad (1)$$

$$\text{and } V = \frac{10.5\ a_1\ d_1}{(c.\,m.)_{A}} = \frac{10.5\ a_1\ (d_1 + d_2)}{(c\ \ m.)_{B}} = \text{etc.} \quad (2)$$

The above is the arrangement usually adopted for the main supply feeders from a central electric light station to the various centres of distribution, for incandescent lighting, and it gives, under full load, the same drop on each feeder, and a uniform potential at the points A, B, C, etc.

But it is in many cases found advisable to unite these separate lines into a single wire of varying section, especially in railway installations, where absolute uniformity of potential is not so essential; and just here is where the mistake is so frequently made, in supposing that by substituting a single wire of a section equal, at each point, to the sum of the sections of the smaller wires at that point, the same results will follow. The fact is that, instead of getting a uniform potential at A, B, C, etc., as before, we shall evidently have a higher potential at A, and a lower potential at F, Fig. 2, and the drop at the extreme end of the circuit will be greater than the maximum allowable; it will be the sum of the several losses between S and A, A and B, B and C, etc.; or,

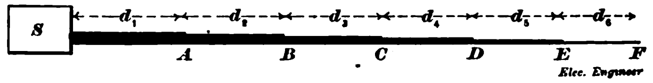


FIG. 2.

$$V_F = \frac{10.5 \times (a_1 + a_2 + \ldots a_6)\ d_1}{(c.\,m.)_{SA}}$$
$$+ \frac{10.5\ (a_2 + a_3 + \ldots + a_6)\ d_2}{(c.\,m.)_{AB}} + \ldots . + \frac{10.5\ a_6\ d_6}{(c.\ m.)_{EF}}; \quad (3)$$

where $(c.\ m.)_{SA}$, $(c.\ m.)_{AB}$ $(c.\ m.)_{BC}$, etc., represent the circular millage of the single conductor between S and A, A and B, B and C, etc., and V_F is the drop in volts between S and F.

If the wire were made of uniform circular millage, represented by $(c.\ m.)_{U}$ as in Fig. 3, the above expression becomes

$$V_F = \frac{10.5 \times (a_1 + a_2 + \ldots + a_6)\ d_1}{(c.\ m.)_{U}}$$
$$+ \frac{10.5\ (a_2 + a_3 + \ldots\ a_6)\ d_2}{(c.\ m.)_{U}} + \ldots . + \frac{10.5\ a_6\ d_6}{(c.\,m.)_{U}} \quad (4)$$

or, rearranging,

$$V_F = \frac{10\ 5 \times a_6\ (d_1 + d_2 + \ldots + d_6)}{(c.\ m.)_{U}}$$
$$+ \frac{10.5 \times a_5\ (d_1 + d_2 + \ldots + d_5)}{(c.\ m.)_{U}} + \ldots . + \frac{10.5\ a_1\ d_1}{(c.\,m.)_{U}} \quad (5)$$

Substituting equations (2) in this, it becomes,

$$V_F = \frac{V\ (c.\ m\ )_{A}}{(c.\ m.)_{U}} + \frac{V\ (c.\ m.)_{B}}{(c.\ m.)_{U}} + \ldots . + \frac{V\ (c.\ m.)_{F}}{(c.\ m.)_{U}} \quad (6)$$

In order that this expression shall be equal to V, we must have $(c.\ m)_{U} = (c.\,m.)_{A} + (c.\ m.)_{B} + \ldots . + (c.\ m.)_{F}$

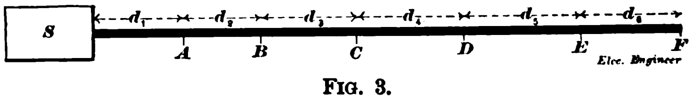


FIG. 3.

In other words, if for the wires in Fig. 1, there is substituted a single wire of uniform section, that section must be equal throughout its whole length to the aggregate circular millage of all the wires, taken at the point where that aggregate is greatest, (*i. e.*, at S), in order to obtain the same drop at the point F as before. This arrangement, therefore, requires a greater amount of copper than that shown in Fig. 1, to secure the same maximum drop; but it is to be noted that this additional copper effects a reduction in the *average* loss on the line.

The question then arises, could not an arrangement similar to that in Fig. 2 be devised, with a tapering conductor, which would require less copper than one of uniform size, for the same maximum drop at the extreme end. Thus we have the problem: To find what arrangement of tapering conductor, for a given distribution of load, will require a mimimum weight of copper for a given drop at the extreme end.

To solve this problem, assume first the simplest case, as in Fig. 4, where the conductor is tapped at two points, A and B, the current consumed at A being a_1, and at B, a_2. The volts drop at B will be

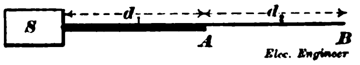


FIG. 4.

$$\frac{10.5 \times (a_1 + a_2)\, d_1}{(c.\ m.)_{SA}} + \frac{10.5\ a_2\, d_2}{(c.\ m.)_{AB}} = V_B \qquad (7)$$

The weight of copper wire per foot is $w = \frac{c.\ m.}{k}$, where $k = 330{,}400$; and we have

$$(c.\ m.)_{SA} = k\, w_{SA}; \qquad (8)$$
$$(c.\ m.)_{AB} = k\, w_{AB} \qquad (9)$$

when w_{SA} and w_{AB} are the weights per foot of wire between S and A, and A and B, respectively. Substituting these expressions in (7) we have

$$V_B = \frac{10.5 \times (a_1 + a_2)\, d_1}{k\, w_{SA}} + \frac{10.5\ a_2\, d_2}{k\, w_{AB}} \qquad (10)$$

The total weight of copper will be

$$d_1\, w_{SA} + d_2\, w_{AB} = W, \qquad (11)$$

which is to be a minimum.

Let
$$\frac{w_{SA}}{w_{AB}} = r; \qquad (12)$$

then (10) becomes

$$V_B\, k\, w_{SA} = 10.5 \times (a_1 + a_2)\, d_1 + 10.5\ a_2\, d_2\, r;$$

and (11) becomes
$$\frac{W}{w_{SA}} = \frac{d_1 r + d_2}{r} \qquad (13)$$

Multiplying;

$$V_B\, W k = 10.5 \times [\,(a_1 + a_2)\, d_1 + a_2\, d_2\, r] \times \frac{d_1\, r + d_2}{r};$$

from which
$$W = \frac{10.5}{V_B\, k} \times \left[(a_1 + a_2)\, d_1^2 + a_2\, d_2^2 + a_2\, d_1\, d_2\, r + \frac{(a_1 + a_2)\, d_1\, d_2}{r} \right],$$

which is to be solved for a minimum with respect to r.

Omitting constants we have:

$$\frac{d}{dr}\left(a_2 r + \frac{a_1 + a_2}{r}\right) = a_2 - \frac{a_1 + a_2}{r^2} = 0, \text{ and } r^2 = \frac{a_1 + a_2}{a_2},$$

from which we have,
$$\frac{w_{SA}}{w_{AB}} = \frac{\sqrt{a_1 + a_2}}{\sqrt{a_1}}.$$

That is, for this particular case the weight per foot, and therefore the circular millage at each point, should be directly proportional to the square root of the current in amperes at that point.

Now take the general case of a tapering conductor tapped at any number of points, as in Fig. 2. Suppose the law for minimum weight to be different from that just given, and suppose that the conductor be arranged in accordance with the correct law to secure the minimum weight of copper; and suppose that for any two contiguous sections, CD and DE, the circular millage be *not* proportional to the square root of the current carried. We can without changing the drop between C and E, and, therefore, without altering the maximum drop at the end of the line, make the circular millage of these two sections proportional to the square root of the currents carried. From what has just been proven, this arrangement will require less copper than before on these two sections, and therefore less in the total, since the other portions of the conductor are not changed. But this is contrary to the hypothesis assumed, viz., that we could have a correct arrangement for minimum weight, under a different law from that proven for two sections; hence that hypothesis is false, and the law is general, since it must apply to any two contiguous sections of the conductor, and therefore to all parts of the conductor; and we have the following

RULE.

To arrange a tapering conductor, tapped at several points, so as to secure the minimum weight of copper for a given drop at the extreme end (or what is the same thing, to secure a minimum drop at the extreme end with a given weight of copper), the circular millage at each point should be directly proportional to the square root of the current in amperes passing that point.

It sometimes occurs that the *total loss of energy* (in watts or horse power) on the whole line is a more important item than the drop in volts at the extreme end. Let this total loss in watts be represented by L. Again take the simplest case of a conductor tapped at two points, Fig. 4. The drop in volts between S and A will be $\frac{10.5\ (a_1 + a_2)\, d_1}{(c.\ m.)_{SA}}$ and the watts loss will be $\frac{10.5 \times (a_1 + a_2)^2 d_1}{(c.\ m.)_{SA}}$ or substituting (8), $\frac{10.5 \times (a_1 + a_2)^2 d_1}{k\, w_{SA}}$.

Similarly, the watts loss between A and B will be

$$\frac{10.5 \times a_2^2\, d_2}{k\, w_{AB}}$$

and $L = \frac{10.5 \times (a_1 + a_2)^2\, d_1}{k\, w_{SA}} + \frac{10.5 \times a_2^2\, d_2}{k\, w_{AB}}$; or substituting (12), $L = \frac{10.5}{k\, w_{SA}} [(a_1 + a_2)^2\, d_1 + a_2^2\, d_2\, r]$.

As before, (13), $\frac{W}{w_{SA}} = \frac{d_1\, r + d_2}{r}$, which gives

$$L = \frac{10.5}{W\, k}\left[(a_1 + a_2)^2 d_1^2 + a_2^2\, d_2^2 + a_2^2\, d_1\, d_2\, r + \frac{(a_1 + a_2)^2\, d_1\, d_2}{r}\right];$$

and for L a minimum, we have

$$r = \frac{a_1 + a_2}{a_2} = \frac{w_{SA}}{w_{AB}}.$$

That is, the cross section should be proportional to the current. By the same process of reasoning as before we can show that this rule will apply to a conductor tapped at any number of points, and we have the general

RULE.

To distribute a given weight of copper in a conductor tapped at several points in such a manner as to secure the least possible total loss of energy in watts or horse power, the cross-section should be proportional at every point to the current passing that point.

These two rules, while they may in many cases be incapable of exact application, owing to varying or unknown conditions, will always serve as a guide in laying out a system of conductors, and will often effect a considerable saving in investment for copper.

A NEW PRIMARY BATTERY.

MR. MOND (of the firm of Brunner, Mond) has found that by passing mixed hydrogen and carbonic oxide over nickel and cobalt he can separate them, and then, by applying the hydrogen, as in Grove's experiment, to strips of platinum, he gets a powerful battery. This battery will yield, it is stated, 50 per cent. of the total energy in the hydrogen absorbed.

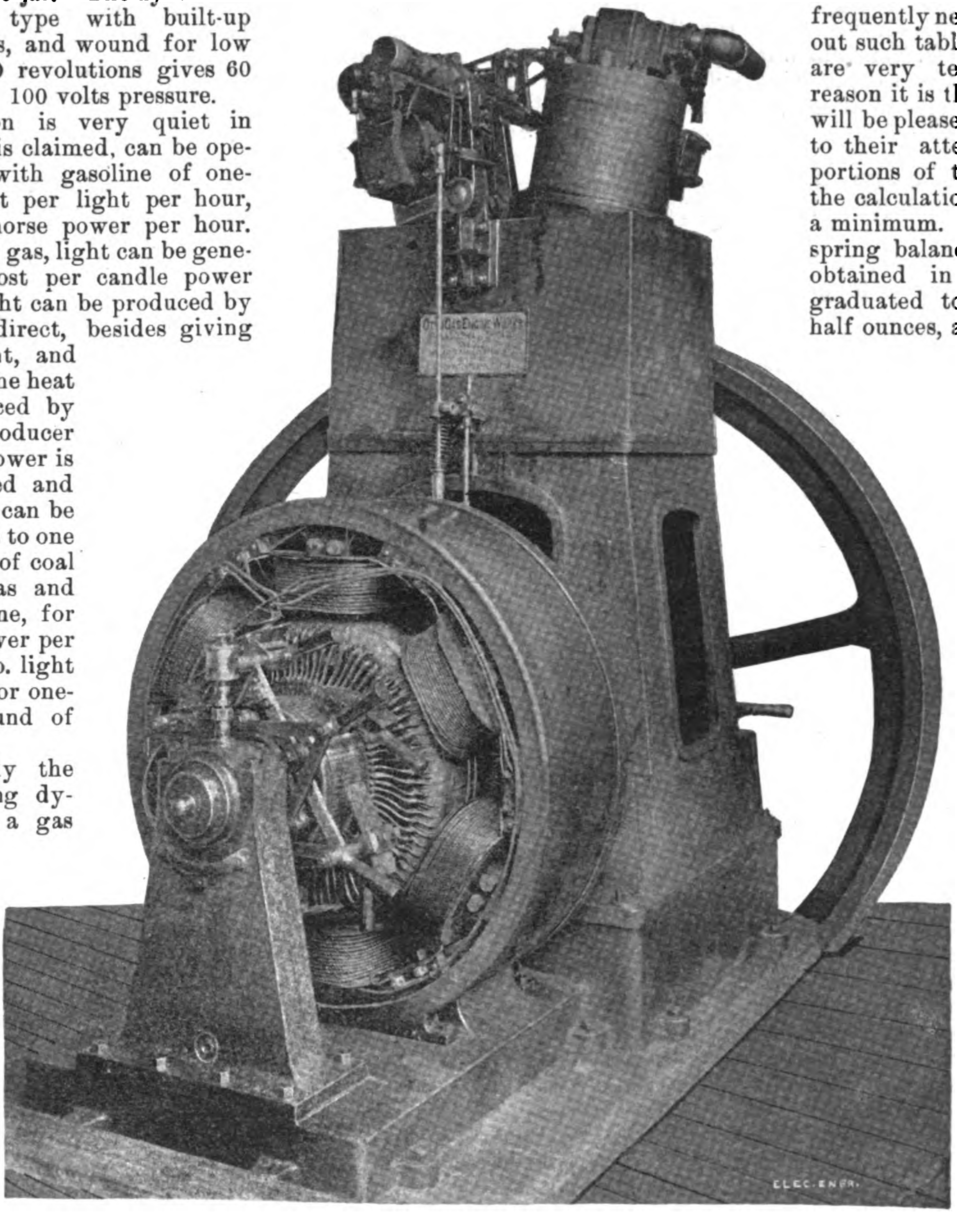
COMBINED GAS ENGINE AND DYNAMO FOR ELECTRIC LIGHTING.

THE accompanying illustration represents a 35 h. p. gas or gasoline engine, and slow speed multipolar dynamo, capable of giving 350 16 c. p. incandescent lights or 35 arc lights. The gas engine is of the well-known Otto type, designed and built by the Otto Gas Engine Works, of Philadelphia. It has the same valves as are used on the ordinary Otto engine, but has two cylinders with cranks at 180 degrees, so as to balance and to run at a high speed without perceptible jar. The dynamo is of the six-pole type with built-up wrought iron fields, and wound for low tension, and at 250 revolutions gives 60 volts, and at 300, 100 volts pressure.

The combination is very quiet in operation and, it is claimed, can be operated at a cost with gasoline of one-tenth of one cent per light per hour, or one cent per horse power per hour. With illuminating gas, light can be generated at a less cost per candle power than the same light can be produced by burning the gas direct, besides giving a much better light, and doing away with the heat of the light produced by the gas. With producer gas the cost of power is still further reduced and one horse power can be produced from one to one and a half pounds of coal converted into gas and used in the engine, for each one horse power per hour, or one 16 c. p. light can be produced for one-tenth of one pound of coal per hour.

This is probably the first direct running dynamo driven by a gas engine, and as such is a very interesting experiment, it having been assumed that a gas engine could not be made to run steadily enough to give a steady light. But with a heavy fly-wheel and the double-cylinder arrangement, it has been found practicable to bring down the variation to less than one-half volt, due to the impulse of explosion of the charge in the cylinder, which is scarcely noticeable in the lights; and, where a storage battery is used in combination, a perfect light is given at a very low cost. Where a steam plant and a skilled engineer are not desirable, this combination affords a solution of the problem. By turning the switch the storage batteries are made to start the engine, the dynamo acting as a motor until the engine is started; then, by shifting the switch, it can be made either to store the batteries again or to furnish the current to the lights direct.

This combination is due to Mr. George S. Strong, of this city and one of these engines and dynamos can be seen in operation at the works of the Otto Gas Engine Co., in Philadelphia.



OTTO GAS ENGINE WITH DIRECT COUPLED DYNAMO.

PRONY BRAKE CALCULATIONS.

BY

Chas. E. Emery

SOME experimenters are provided with tables showing by inspection the horse power due to a given number of revolutions and a given strain on the scale of a Prony brake. Even then interpolations are frequently necessary, and without such table the calculations are very tedious. For this reason it is thought that many will be pleased to have brought to their attention such proportions of the apparatus that the calculations are reduced to a minimum. For small powers spring balances can be readily obtained in stock that are graduated to ounces or even half ounces, and in any case it is as easy to reduce to ounces as to decimals of a pound. If, then, the distance from the centre of the jaws gripping the pulley to the point of suspension of the balance be made 10.084 inches, instead of one foot, as is customary, *the horse power may be found at once by simply multiplying the strain on the scale, reduced to ounces, by the number of revolutions per minute and pointing off five places of decimals.*

For if $P =$ the horse power, $R =$ the radius in feet and $R_1 =$ the radius in inches; $w =$ the weight in pounds and $z =$ the weight in ounces, and $r =$ the revolutions per minute, we have:

$$P = \frac{2\pi R w r}{33000} = \frac{R_1 z r}{1008403}.$$

If R_1 be made 10.084 inches, as proposed, evidently

$$P = \frac{z r}{100000} = \frac{z r}{10^5}.$$

A double-flanged pulley should always be used with the brake. The tendency of the wooden jaws to grip on the pulley as it becomes heated may be prevented to a considerable extent by putting a spring under the nut on one of the clamping bolts, and this arrangement is also conducive to steadiness of the balance spring.

HOW HOUSE SERVICES ARE PUT IN BY THE EDISON ELECTRIC LIGHT COMPANY, OF PHILADELPHIA.

BY

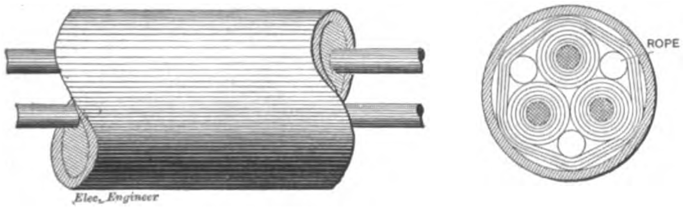
Jos. D. Israel

(Superintendent of Street Work.)

In the March 30 issue of The Electrical Engineer, there appeared an instructive article on the manner of putting in a house service from the Edison three-wire system in New York, from which it appears that the Edison companies have not as yet departed wholly from the underground tubing, and adopted the more economical and advantageous system of cable connections for service work. As we live to learn, it would not be amiss to relate briefly the positive success of cable service connections as laid and maintained by the Edison Electric Light Company, of Philadelphia.

There is a general belief in the world at large that nothing of an original or progressive nature can receive its birth or early nourishment in the "City of Brotherly Love." In spite of this prejudice the conviction is being carried to the electrical world that Philadelphia is abreast of the times in matters of moment to the electrician.

The cable services of the Philadelphia Edison Company should attract the attention of all electric companies maintaining an underground system. The Edison companies, particularly, should examine this means of reducing their expenses.



Making a House Service in Philadelphia.

The cable employed consists of the three copper conductors of the desired diameter. The Philadelphia company uses three sizes, of Nos. 41, 80 and 160, Edison Standard Gauge. They find these sizes available for all practical cases. Two services of 160 cable are used in places where an extraordinary load is to be carried.

The coppers are separated by spiral windings of hemp rope (see Fig.) the space between being filled in with resin and cotton seed oil. The rope braid is wrapped around the cable, and then it is encased in a one-eighth inch lead covering. The lead is painted with a waterproof paint. The resistance is very high, and the practical problem thus solved is simply to give the *coppers* more rope as insulation.

The advantages of using this cable in place of a rigid iron tube are readily observed by following the manner of putting in a service. For this purpose the trench is dug and the coupling box on the main is uncovered. On account of all services being made on a live line it is not good policy to compel your men to work in a tunnel. Give them as much working room as possible, and insist on the best of workmanship being executed. This will save money in the end, as there will be fewer "burn-outs" to locate.

Do not tear up the sidewalk and get the company into the bad graces of the subscriber. Locate the point of entrance into the cellar, break the wall and then bore under the sidewalk. An ordinary post-hole auger will do the work. In four years' experience it was found that the small number of places in which the auger had to be abandoned and the sidewalk torn up were overwhelmingly outnumbered by the successful use of the auger in over 95 per cent. of the undertakings.

The trench is ready, and now comes the advantage of cable over tubing. The measurement is taken, and only one piece of cable is required. What matters it if there is a gas main to go under and then a telephone conduit to go over? What matters it if the coupling box on the main is one foot outside of the house line? The cable is pliable and all these obstacles can be readily overcome. Avoid sharp turns.

With this method there is no tubing to be cut; no short pieces are needed; no elbow-pieces are to be laid; no elbow joints, no elbow boxes; no coupling joints, and no coupling boxes are required. Then think of the saving in the use of that expensive necessity—compound. Only one joint is to be made, namely, the connection of the cable to the main; no salary for a tester. The cable is tested on the reel, this answering for about 20 services. Cable is cheaper than tubing per foot; cable couplings are cheaper than joints. The T-box is put on and you have saved dollars in material and time. As well as locating the work for the street plans, it will be found to be good business policy, as an item of reference from both a financial and engineering standpoint, to adopt some system of recording the work done, with the expense attached. The Philadelphia company uses the following form:

Order Ticket for Services and Meters.

Order No.......................... Page............
Name..
Premises..
Ordered by..............................Date..............189
Order...
What done...
Done by.................................Date..............189
Foreman.
Permit....................Meter.............................
Cable.....................Cut-out...........................
T-Box.....................Wire..............................
Service End Box...........Miscellaneous.....................
Clamps....................Labor.............................
Miscellaneous...
Labor...
Total...
Credit Material Returned....................................
Net Cost..
Entered by..

Be sure to designate the size of the service. It will be a great guide when the subscriber wishes an increase in light or power. You will then be able to tell at a glance if the service will carry the increased load. It is always well to allow for such an increase as it is sure to come in some degree at an early date.

In two and a half years' experience in the practical use of this cable, under all existing circumstances, the company has yet to find the first trouble of any kind. When it is borne in mind that over 500 services are thus connected, it is a record hard to beat. To Prof. Wm. D. Marks, the president and supervising engineer of the Philadelphia Edison Company, is due the adoption of this cable.

INSULATED ELECTRIC CONDUCTORS.[1]—V.

BY

James Bowstead Williams M.D.

Chap. IV.

If we were to make a list of *all* the substances which are specified and claimed in letters patent for insulating material issued in the United States and England, we would find the number of such substances to be between two and three hundred; and this list would include almost everything that could be wrapped around, or secured to, electric conductors. Many of these substances are utterly worthless as insulating media, for they possess no insulating properties of themselves, nor can they be used to any advantage in combinations with good insulating material; and why they were secured by patents the inventors or discoverers alone know.

The number of really useful insulating substances is smaller than is generally supposed, seeing that we have such a large number to select from; but that the reader may know what is generally used for insulating purposes the following list has been compiled, which includes substances from which the different kinds of insulating material are made. It may be added, with reference to some of the substances included, that in one or two instances it has not been deemed necessary to enlarge in detail on every one of them.

The arrangement of the substances under the different headings is made simply for convenience of reference.

Gums.—India-rubber, gutta-percha and balata.

Resinous Bodies.—Colophony, shellac, Venice turpentine, copal, dammar, pitch, turpentine, amber, mastic, sandarac, animé and kowrie.

Vegetable Oils and their Products.—Linseed, cotton-seed, castor, olive and rosin oils; oxidized oils, sulphurized oils and elastikon.

Waxes.—Beeswax, paraffine, ozokerite and spermaceti.

Mineral Oils.—Petroleum, paraffine, and liquid paraffine.

Petroleum Products.—Asphalt, bitumen, maltha, residue and redistillates of residue.

Tars.—Coal and wood.

Fibrous Material.—Silk, cotton, jute, paper, parchment, cellulose and asbestos.

Mineral Substances.—Mica, silica and silicates, glass, kaolin, chalk, magnesia, talc, plaster, lime, sulphur and sulphides, oxides of lead and zinc, and asbestos.

Miscellaneous.—Lampblack, graphite, leatheroid, vulcanized fibre, liquid glass, stearine, glycerine, hard rubber, coal tar asphalt and celluloid.

In the present series of articles information relating to the origin, general properties, etc., of the substances enumerated in the foregoing list will not be given, as such information can be obtained from encyclopedias and other works of reference. The writer will, therefore, confine himself to a discussion of matters of practical importance worthy of the closest attention and study of the electrical engineer, but not to be found in any of the books. In other words, he proposes that these articles shall be a narrative of investigation and not a mere compilation of data already recorded and within everybody's reach.

India-Rubber.—This is one of the most important insulating bodies known; in many respects it is superior to all others for general purposes of insulation in that—1. It has a very high specific resistance. 2. It can be used alone to insulate all classes of electric conductors. 3. It can be used to form useful combinations with all other good insulating material. 4. When properly used it is to a high degree permanent and anhygroscopic. 5. It retains its insulating properties at comparatively high temperatures. 6. It does not readily soften by heat.

All rubber consists of two distinct bodies or modifications, both of which are identical and similar as regards their general properties. One of these modifications is hard or fibrous, and the other soft and viscous. It is this latter which causes freshly-cut pieces of rubber to unite when placed in contact with each other, and also which is vulcanized, or cured, by the action of sulphur.

As stated in a previous article, the best rubber for insulating purposes is the Para (from South America). If a perfect "biscuit"—so called from the form of the imported lumps—of this rubber be examined, by dissection, it will be found to consist of several distinct layers, closely adhering to each other, and of different colors. The color of the layers varies with the position of the layers in the mass, and depends upon the age of the rubber and also upon the care taken to protect the milky juice of the trees while it is being coagulated to form the biscuits.

The color of the outer and exposed layers is usually a dirty brown, and each succeeding layer has a lighter color until the inner and protected layers are reached, which have a milky-white color. This white rubber is the pure unoxidized coagulated milk of the trees, and its specific resistance is much higher than that of the darker colored and oxidized rubber of the outer layers. But if this pure-white rubber is left exposed to air and light it gradually gets darker colored (oxidized) until it has the brown color of the outer layers of the original lump; and as its color changes its resistance diminishes. If this oxidization continues, the rubber finally deteriorates to a brittle resinous mass, and it is then useless for electric insulation.

All rubber being porous and cellular, its porosity is increased by subjecting it to the washing process, which is done to remove dirt and other foreign matters; so that washed rubber, unless protected, will absorb oxygen and moisture and deteriorate faster than the unwashed.

When used for insulating purposes, rubber should *always* be combined with a "preservative" material which does not, of itself, readily oxidize. Pure paraffine wax is a good preservative, but unless it is combined with a soft resinous body—which acts as a cement for the rubber and paraffine,—it is very apt to separate from the rubber, and almost always does separate from it, when the vulcanized product is heated. Beeswax also acts as a preservative, when used in the same manner as paraffine. Either paraffine or beeswax and resin can be combined with rubber by first melting the wax and resin together, and then filling the pores of the rubber with this material by means of heat and a vacuum; or by melting together, and then "working" this compound with the rubber on hot mixing rolls; or by dissolving the three ingredients in a volatile solvent, mixing the solutions, and then distilling the solvent. By employing the latter process all danger of overheating the materials is avoided. After the rubber and preservative are combined the combination is ready for the incorporation therewith of other ingredients, on hot mixing rolls. If much paraffine is used as a preservative the compound is easily softened by heat, and special precautions have to be taken to keep wires concentric with the compound during vulcanization.

Inert powders, such as chalk, etc., when combined with rubber do not tend to preserve it, like the waxes. Combining rubber with one or more powdered substances simply distributes the rubber throughout the mass; there is nothing present to preserve it, and as soon as it deteriorates the mass gets full of cracks and becomes worthless.

Rubber should never be used unless *absolutely* dry. All rubber, before and immediately after washing, contains more or less moisture; in some cases, as much as one-fourth of the entire weight. One cannot be *too* careful to have the rubber dry; and, if possible, *all* rubber should be kept, after washing, in a warm dry room, free from light and dust, for several months, or else be kept exposed, when in very thin sheets, to a current of hot dry air for several days, before it is used. If the rubber be free from moisture, not only will the dielectrics of which it forms a principal ingredient have a much higher insulation resistance, but the dielectric itself, if properly used, will be much less liable to subsequent deterioration than if the rubber contained but a small amount of moisture.

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Rubber *can* be kept pure and dry, after washing, for many years. The writer has used Para rubber which had been washed over five years previously, yet the color of the exposed portions of the washed sheets remained a reddish brown and that of the unexposed portions a clear white. The specific resistance of this rubber was phenomenal, when compared with the ordinary washed Para, its elasticity was greater, and its consistency firmer.

If the milk of the rubber trees were imported in opaque bottles or other vessels instead of in the coagulated form, the milk could be coagulated by the manufacturer of insulated wires and cables, and any foreign matters, such as dirt, bits of bark, etc., could be removed by dissolving the dry coagulated mass and filtering it. The resulting product would then be pure and unoxidized, and it would have all the properties of the pure gum, which are far different from those of the ordinary spongy, washed material.

Para rubber loses from 10 to 20 per cent. of its weight by cleaning. This loss consists of moisture, dirt, stones, bark, etc. All of these substances being detrimental to insulation, it is necessary that the rubber used for insulation should be more thoroughly cleansed than that used in the manufacture of rubber goods. Small pieces of wood or stone in a rubber dielectric may indirectly cause the loss of a costly cable.

Vulcanizing rubber does not increase its specific resistance—under certain circumstances it may diminish it—but the vulcanized material will not crack, when bent, at low temperatures, nor soften at high temperatures, as readily as the unvulcanized material.

The amount of rubber necessary to impart flexibility to vulcanized dielectrics depends upon the materials with which it is incorporated, and can be ascertained only by experiment. Most of the vulcanized dielectrics now in use contain from 25 to 40 per cent. of rubber. But there are "vulcanized" dielectrics which are tough and flexible and yet contain little or no rubber.

Ozone rapidly attacks and destroys rubber. As ozone is always formed whenever a brush discharge occurs in air, all exposed rubber-covered wires in the immediate vicinity of a brush discharge soon become useless. This brush discharge may occur between the bare wires of two neighboring conductors or even between two insulated conductors, if there are any cracks or other breaks in the dielectrics. An ozone-producing discharge may also take place over the surface of hard rubber or other insulating material if such material has minute particles of conducting matter thickly scattered over, and retained upon, its surface.

Several solvents of rubber are given in "the books," but many of these, when evaporated from the rubber solutions, do not leave the rubber in its original condition. Bisulphide of carbon, with a small per cent. of absolute alcohol added (to absorb any moisture in the rubber), is the best and cheapest solvent to use in the manufacture of insulated conductors, notwithstanding its first cost, because it can be recovered, with practically no loss, after it has been used to deposit a thin layer of rubber either upon a tinned wire or upon a layer of insulating material insoluble in the solvent. A thin layer thus applied adheres much more firmly to whatever is beneath it than if the layer were formed of a thin strip wound upon the underlying material.

Any one wishing to examine pure rubber can obtain it by evaporating the juice of the common milkweed which contains it.

Further items of importance concerning rubber will be mentioned under other headings.

NOTE ON LIGHTNING PROTECTORS AND NON-ARCING METALS.

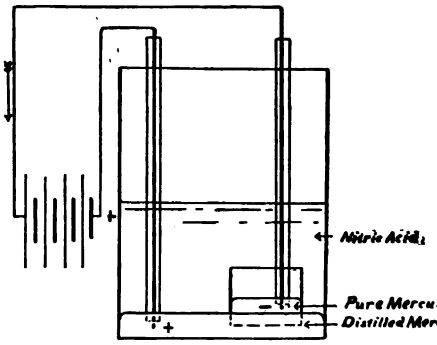
BY

A. K. McCay.

Two of the non-arcing metals, zinc and mercury, present a very curious phenomenon when combined. On investigation of the conductivity of either metal at different temperatures it will be found that both zinc and mercury follow Matthiessen's formula, $c = 100 - 0.37647\,t + 0.0008340\,t^2 +$ etc. Several years ago while carrying on some experiments under Prof. Helmholtz, in Berlin, he proposed to me during a lull in other work, that I should investigate the resistance of zinc and mercury combined in different proportions. This experiment I undertook.

To obtain pure zinc I distilled commercial zinc, and, after treating it with special chemical processes I tested the same by spectroscopic analysis, using one of Rowland's ruled glasses which give lines whose wave lengths were measured and from which the purity of the zinc was undeniably demonstrated.

When the question of pure mercury came up, I found that even after distilling and treating by chemicals, I still did not have pure mercury. After consulting various authorities, I asked Prof. Helmholtz and he suggested the following method, which I shall briefly describe: After obtaining the finest mercury by distillation and removing, as far as possible, all foreign metals, I placed it in a glass jar as shown in the accompanying diagram. I then poured concentrated nitric acid on top of the same. Then taking a small glass cup I placed it on top of the mercury and allowed it to float. Then I placed the platinum wire which made the positive (+) pole of my battery, consisting of some four Bunsen cells in multiple, in the mercury beneath the acid, having the wire leading thereto carefully insulated from the acid by a glass tube. The negative pole was placed in the small cup, which was entirely covered with acid. In this way in about one week's precipitation I procured one-eighth pound of mercury, which was ample for my purpose.



METHOD OF OBTAINING PURE MERCURY.

Having obtained the mercury and zinc, I made my amalgams, and found that in every case they decreased in resistance, which is exactly opposite to what one would be inclined to expect. Mr. Wurts in his recent Institute paper says he found that the paste made from zinc and mercury was an arcing metal, while pure zinc and mercury were non-arcing. It appears to me, then, that Mr. Wurts' theory of the action of non-arcing metals, viz., that a vapor of high resistance is momentarily projected between the poles, breaking the arc, is correct. The resistance of zinc and mercury both increase with the temperature, and at the high temperature of an electric arc must be very high, but if the amalgam decreases with high temperatures then it follows very closely that this paste would be non-arcing. This agrees with Mr. Wurts' results.

Press of other work compelled me to abandon the investigation, and I had not recalled it till I heard of Mr. Wurts' exhaustive and able paper. The subject is very interesting and instructive, and I hope he will pursue his investigations further, particularly studying the arc in a vacuum.

ARC LIGHT WIRING.

BY

S. H. Sharpsteen

Mr. W. B. Rommel's comments[1] on my article[2] on arc light wiring may mislead parties who are not very well versed in the electric lighting business. Persons conversant with the business will see at once the point at issue, and if they have not thought over the system previous to seeing my article, will understand that it is good under the circumstances which I mentioned.

In the average town the commercial lamps are very nearly all on one street and short streets off from it. The municipal lamps are, as a rule, two blocks apart. Mr. Rommel seems to think that the main street cannot be without the city wire for a time to make a loop and come back two or three blocks below or above. He speaks of putting one side of the street circuit on one street and the other side on another, or down one street and up another. Such a town would have to be made up of two long streets with short ones intersecting and in this long and narrow town the three-wire system of arc wiring is at its best as it is cheaper to loop down to the lamps on the second street at every block than it is to build another pole line. If the town is deeper than three streets the looping has got to be done anyhow.

Mr. Rommel speaks of the arc lamps that he has installed running the full current through the magnet coils after the lamp is cut out and this current passing through the magnet coils interfering with the adjustment of the lamp, etc. Will Mr. Rommel please give us the name of the arc lamp that he speaks of?

Mr. C. G. Young in his article[3] puts the matter in the proper light to lead a person into the pros and cons. When I wrote the article I had in mind small stations of from 50 to 80 arc lamps. Stations from which a large number of street lamps are worked have no particular use for this system on their street light circuits at any rate. To get the economy down directly to dollars and cents, as Mr. Young speaks of, was not the point I had in view either.

In the installation of a plant for public lighting one of the very prominent questions that suggest itself is, "How can we avoid having the commercial lamps out?" To get good prices, good service must be rendered. A commercial arc circuit that is out oftener than once a year is not a success; once in five years I consider bad if it be out for any length of time. It is understood here that what is meant by being out is not to have the light when it is customary.

Another question is, can a street circuit for street lighting be as proof against being "open" as a commercial, or, better, an inside, commercial circuit? This question, I think, is very easily answered in the negative. An inside commercial circuit put up by the right man will never get "open" we may say, but of the outside circuit, suspended in various ways, full of loops running to lamps in centre of streets and to all kinds of fixtures, the wires are liable to get broken or worked loose. A plant could not be installed for me and have the inside commercial lamps on circuits with street lamps, as street lamps are now installed. Again, when the street lamps are in circuit with the commercials, if they be of equal number and equally proof against open circuits, the commercials have double the chance of being out from open circuit. There are a great many towns where they have from 50 to 80 arc lamps very nearly equally divided between municipal and commercial or inside and outside lamps. For good service at times during the year the inside lamps have to be started as early as 3.30 and 4 p. m.; 5.30 would be early enough for the street lights at the time mentioned above. Some towns use their street lights until 12 and 1 a. m. only. Twenty-five or forty arc lamps worked for 1½ hour is quite an item, and with the people that have no street lights after 1 a. m., the run from 3.30 p. m. until 1 a. m. is too long for single lamps with $\frac{7}{16}$ carbons, which it is economy to use.

From 10 years' experience in connection with both large and small stations, I conclude that if there are to be worked 50 or up to 80 arc lamps about equally divided between outside and inside lamps, I should want the inside lamps on a separate circuit. If there are to be two circuits it is evident that it is cheaper to put commercials on one side, street lights on the other and at the last commercial or the last street lamp connect on a third wire and run the same to the station.

It may seem a little obscure to some what I mean by the outside and inside lamps being on separate circuits when in fact they are both on one circuit. The point is here: With the three wires at one's service, if the arc circuit goes out from outside trouble the person in attendance can close the inside lamp loop through the third wire and if the trouble is on the other leg, his commercials will come up at once.

THE ENERGY CONSUMED IN ARC LAMPS UNDER VARIOUS CONDITIONS.

BY

Frank B. Widmayer

In regard to the discussions in The Electrical Engineer, on "Economy in Arc Light Wiring," and referring especially to Mr. Rommel's article in the issue of March 30, I give below the results of some experiments I made on two well-known arc single-carbon rack lamps, one a 10-ampere 2,000 c. p. lamp and the other a 4-ampere 800 c. p. lamp. The readings for voltage were taken across the binding posts and the average of a number of readings taken is given. The current readings were taken in the usual way by ammeter; the instruments used were the well-known Weston ammeter and voltmeter.

The object of these experiments was to determine three things, namely:

First, energy in watts required to run the lamp under normal conditions.

Second, energy in watts consumed or wasted in lamp after carbons were consumed and dropped together and so cut out or burnt out, the current going through lamp, coils, and carbon stumps.

Third, energy in watts consumed in lamp after being cut out by the ordinary automatic cut-out, consisting of two small magnets in circuit, one of very fine wire in shunt and one of coarse wire in the main circuit; when the lamp is cut out, all the current flows through the small coarse wire magnet and armature which short-circuits the lamp between the two binding posts, with no current in the carbons, main line spools or shunts.

The following were obtained on the 10-ampere lamp:

Experiment No. 1.—10-Ampere Lamp.

First Case.—Burning 48 volts and 10 amperes. 480 watts consumed.

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[1] The Electrical Engineer, March 30.
[2] The Electrical Engineer, March 16.
[3] The Electrical Engineer, March 30.

Second Case.—Loss in watts, or drop of potential in lamp with carbons together, current going through carbon stumps, spools, etc. Drop of E. M. F., 4 volts; current 10 amperes, thus, 40 watts consumed or lost in heating carbons, spools, etc.

Third Case.—Energy lost in watts through heating of cut-out coil. Drop, 2 (volts) × 10 amperes = 20 watts.

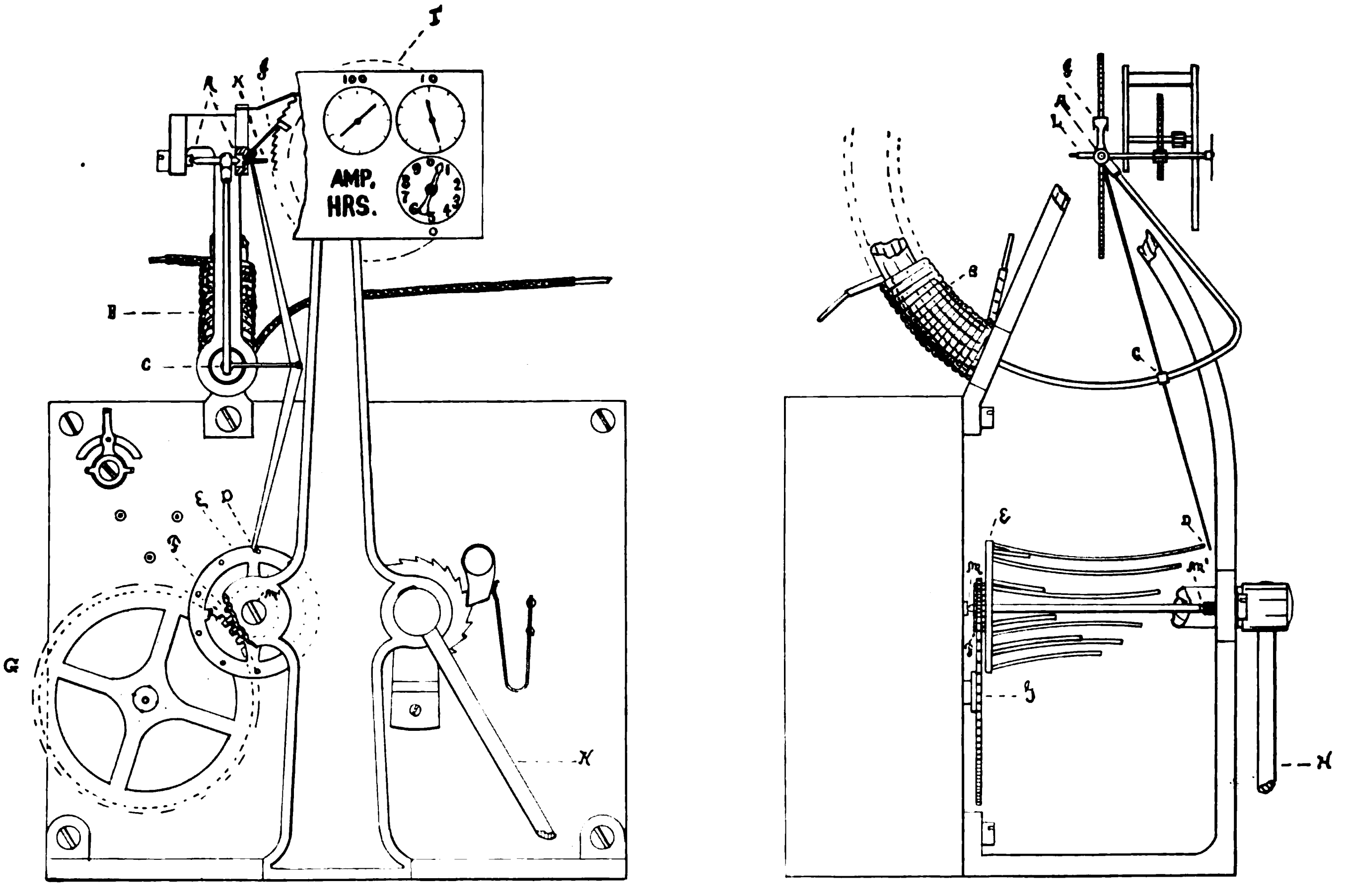
EXPERIMENT No. 2.—4-AMPERE LAMP.

First Case.—E. M. F., 52 volts; current, 4 amperes. 52 × 4 = 208 watts consumed in running lamp.

Second Case.—E. M. F., 4 volts; current, 4 amperes. 4 × 4 = 16 watts lost in heating carbon stumps, spools, etc.

Third Case.—E. M. F., 1 volt; current = 4 amperes. 1 × 4 = 4 watts lost in cut-out.

I think the most economical method of wiring arc lamps, especially in large cities where subway rentals are very high, is to run both the commercial and city lights on the same circuit and by having a good lamp, that is, one having the ordinary cut-out and a special cut-out, such as is described below—there would be no trouble with the service. Let us assume that the city lamps are all-night lamps and the commercial are 7-hour lamps. Start both at the same time, trim the commercial lamps so that they will run the time required and will drop out, that is, the carbons will drop together and close the circuit through the lamp. Have a small pin fixed on the carbon rod in the lamp case; this pin when the rod drops, say ¼ to ⅜ inch, will trip a lever which will short-circuit the lamp across the terminals and so directly cut the lamp out of circuit.



FIGS. 1 AND 2.—FRONT AND SIDE VIEW OF MECHANISM OF THE PILKINGTON-WHITE METER.

If this method were used, I believe there would be a saving of from 30 to 40 watts on each 10-ampere lamp so equipped. Another method, but not as good as the one just described would be to have the pin move the ordinary cut-out lever till it makes contact with the magnet and coarse wire coil; in this case the current would only flow through the coarse magnet in cut-out and so short-circuit the lamp in the usual way.

THE PILKINGTON-WHITE METER.

BY

Herbert M. Pilkington

CONFUCIUS said many centuries ago, "Man believes in his heart only what he sees with his eye." Human nature has not changed—customers want to "see the wheels go round" and to gratify this laudable desire has been the ambition of Mr. R. S. White and myself. The accompanying illustration of size No. 1, 5 amperes, will enable the reader to see how we have done it.

It will be observed that we have employed the simplest and best known elements in use. Every one knows what a gravity ammeter with the minimum of iron can do and millions of clocks in daily use bear their own testimony. A reliable mechanical connection between these elements, free as possible from complication, was our aim—we worked it down to one moving part and stopped for obvious reasons.

Fig. 1 is a front view of the mechanism and Fig. 2 a side view, while Figs. 3 and 4 show the meter as it actually appears. A 40-day clock in dust-proof case drives by gear G and pinion F, the disc E which carries curved pins and D which disc is mounted on a phosphor bronze shaft centered at M and M^1 Fig. 2. At B is an ammeter solenoid; swinging from centres A is its light soft iron core carrying at C a fixed bracket at the outer end of which is freely pivoted a light lever. This lever is forked at the upper end to embrace the steady pin K, and has a pawl J engaging the ratchet wheel I of a dial train. The action is as follows:

The movement is wound by removable crank key H and for 40 days turns disc E around at the rate of five turns an hour.

In this disc is set a pin for each half ampere of the meter's capacity; making in this case ten pins. These are of various lengths corresponding to the calibration of the instrument.

When, say, half an ampere is passing on the coil B, the ammeter moves and carries the lever to a position where it will be struck by the first pin D, Fig. 2, once in every revolution of disc E.

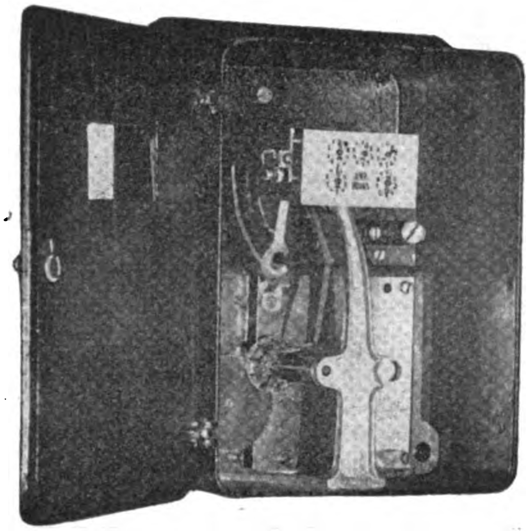


FIG. 3.—THE PILKINGTON-WHITE METER.

For every additional half ampere the arm will move over further and another pin will come into action, until at five amperes the full number come into play.

It will be readily seen that the lever by being pivoted on bracket C and guided at centre K forms an integral part of the ammeter core, at the same time possessing its own plane of rotation at right angles to the latter. Therefore when the pin D moving to the left carries the lower end of the lever in the same direction, the upper end, by pawl J, advances the ratched wheel I a distance of one tooth, then D releases the lever and it drops by gravity into position to engage the next pin. Thus at five amperes the lever will transmit to the wheel ten impulses per revolution of disc or 50 per hour. This wheel has 100 teeth and is geared even with the unit's dial, so 50 impulses mean half a revolution of unit's dial or five ampere hours. The lever being retained only a few seconds by each pin, is always ready to take up a new position as the load is varied. Supposing the load to drop to one ampere, the ammeter falls back, and two pins only will engage the lever, recording thereby 10 teeth in an hour, or one ampere per hour.

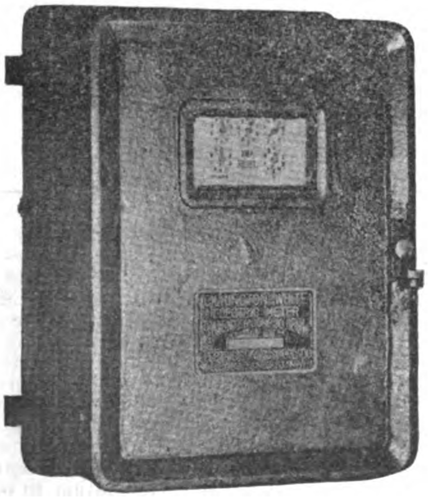


FIG. 4.—THE PILKINGTON-WHITE METER.

This meter is suited to any circuits, introduces no drop, requires no electrical power to run it, and is not affected by short-circuits. The case is iron, insuring freedom from outside influence, and the current may be reversed, as it frequently is in practice, without affecting the reading.

The different capacities all go in the same-sized case, a very desirable feature where numbers of them are handled. This meter has been patented in the United States, Canada, Great Britain, Germany, France and Belgium.

RULES FOR TESTING TELEGRAPH LINES.

BY

F. W. Jones

IN a telegraph company a great desideratum has always been a system of electrical testing that was adapted to the capacity of managers and chief operators having direct charge of the circuits. Heretofore tests have been usually made by the Morse relay and key, and a galvanometer only called in use in a desultory way.

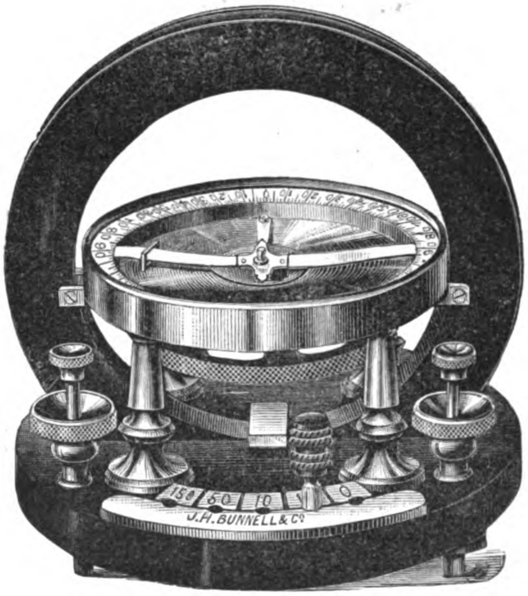


FIG. 1.—TANGENT GALVANOMETER.

The following system that is at once practical and serviceable has been adopted by the Postal Telegraph-Cable Company at all of its principal testing stations, and so expert are the various chief operators becoming in handling the simple apparatus that a vast saving in time and expense has resulted in the repairs of breaks and crosses in the main lines by the location of these troubles through electrical tests; as a repairman is sent directly to the spot. Whereas heretofore a trouble was located between two stations and two repairman, one from each station, were sent to meet each other.

A combined Wheatstone bridge and galvanometer, Fig. 2, is used for the location of crosses and grounds where accurate measurements are necessary. Once each month during a very dry day each station supplied with this instrument makes a careful loop test of all the main line wires within its jurisdiction and forwards the results to the electrician's office at New York. This is to enable the electrician to notice any undue deterioration of the wires.

For insulation and battery tests the tangent galvanometer, Fig. 1, is used, according to rules given below. By the aid of this instrument the chief operator goes rapidly over his wires every morning and notes the deflection upon the galvanometer of 100 volts due to the leakage between the testing station and the farthest limit of its jurisdiction. Referring to the table of degrees the ohms are directly obtained. Should the wire not measure up to its usual resistance, according to the state of the weather then prevailing, the chief operator has the wire opened at the various intermediate offices (if any) and notes the deflections respectively, thereby ascertaining between which two the leakage exists. It is needless to say that compared with this method the old-style relay and key system is very inefficient and crude.

The main batteries are also tested by the tangent galvanometer for internal resistance, which is a good indication of their condition. A special rheostat for use in shunting the tangent galvanometer and for using in the circuit when measuring the internal resistance of the batteries, has the following coils in ohms: 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, 400, 1000, infinity; correct within one-half of one per cent., and the wire coarse enough to carry any battery currents without unduly heating. Should any insulation tests be required on the lines, more exact than can be made with the tangent galvanometer, the Wheatstone bridge is resorted to and the sides multiplied 10 to 100 or 10 to 1,000 in the usual way. More delicate tests of underground or submarine cables are made by more appropriate apparatus furnished by the electrician's office.

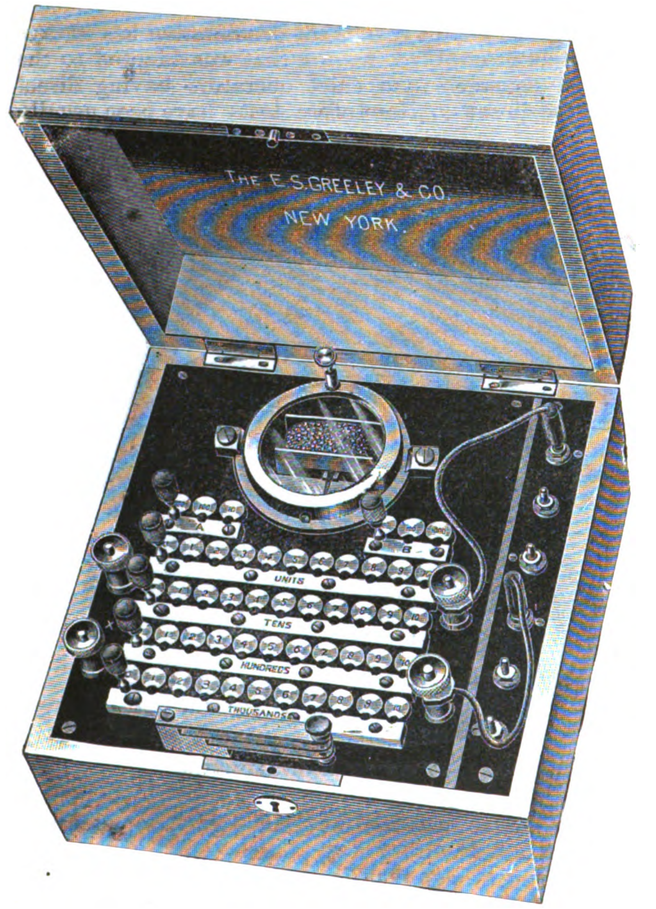


FIG. 2.—WHEATSTONE BRIDGE AND GALVANOMETER.

RULES FOR MEASURING INSULATION FOR SUPERINTENDENTS AND MANAGERS.

The use of the tangent galvanometer for insulation tests of line wires may be facilitated by observing these rules in connection with a table of degrees furnished herewith.

Taking the Constant.

If a battery station, use 100 cells of Callaud battery. (Where dynamos are in use, the positive and negative potential nearest to 100 volts may be employed, care being taken to keep them as nearly equal as possible.) Connect the battery to the tangent galvanometer through 10,000 ohms and place a resistance as a shunt across the terminal of the galvanometer, using the 200-ohm coil, so that part of the current flows through the galvanometer and part through the shunt. Set the galvanometer away from all working electromagnets, with the pointer at zero, and adjust the resistance in the shunt until the pointer is opposite 45 degrees (on the degree scale, not on the tangent scale.) Then remove the 10,000 ohms, ground one pole of the battery and connect the line through the galvanometer to the other pole of the battery, leaving the shunt undisturbed. Note the deflection obtained, say, 24 degrees. Reverse the battery and again note the deflection, say, 32 degrees. Take the tangent number 35.5 opposite 32 in the table and add thereto the tangent number 25.5 opposite 24 degrees, and divide this sum, 61, by 2. Look in the tangent column for the nearest number to 30.5, the quotient obtained. The number 30, being the nearest number so found, will stand opposite the resistance, 18,807 ohms, which is sufficiently exact for purposes of insulation measurements. When the deflections obtained from positive and negative poles are equal, the resistance will be found directly opposite the degree in the table.

POSTAL TELEGRAPH CABLE COMPANY—TABLE FOR INSULATION MEASUREMENTS.

Deflection.		Insulation ohms.	Deflection.		Insulation ohms.
Degrees.	Tangents.		Degrees.	Tangents.	
1	1	572900	44	55	10355
1.5	1.5	430000	45	57	10000
2	2	286000	46	59	9657
2.5	2.5	229000	47	61	9325
3	3	190800	48	63	9004
3.5	3.5	167000	49	65	8693
4	4	143000	50	67	8391
4.5	4.5	128000	51	70	8098
5	5	114300	52	73	7813
6	6	95144	53	75	7537
7	7	81443	54	78	7265
8	8	71154	55	81	7002
9	9	63138	56	84	6745
10	10	56718	57	88	6494
11	11	51446	58	91	6250
12	12	47046	59	95	6008
13	13	43315	60	99	5774
14	14	40108	61	103	5543
15	15.5	37321	62	107	5317
16	16.5	34874	63	112	5095
17	18	32700	64	117	4877
18	19	30777	65	122	4663
19	20	29042	66	128	4452
20	21	27445	67	134	4245
21	22	26051	68	141	4040
22	23.5	24751	69	149	3839
23	24.5	23559	70	157	3639
24	25.5	22460	71	166	3443
25	26.5	21445	72	176	3249
26	28	20503	73	187	3057
27	29	19626	74	199	2867
28	30	18807	75	213	2679
29	31.5	18040	76	229	2493
30	33	17321	77	247	2309
31	34	16643	78	269	2126
32	35.5	16003	79	294	1944
33	37	15399	80	326	1763
34	38.5	14826	81	360	1584
35	40	14281	82	406	1405
36	41.5	13764	83	465	1228
37	43	13270	84	543	1051
38	44	12799	85	653	875
39	46	12349	86	817	699
40	48	11918	87	1090	524
41	49	11504	88	1636	349
42	51	11106	89	3273	175
43	53	10724			

Should the insulation be so high as to produce less than one degree deflection, remove the shunt and read the degrees of deflection without it and multiply the corresponding ohms in the table by the multiplying power of the shunt, which can be found as follows: Measure the resistance of shunt and add it to the resistance of galvanometer, and divide this sum by the resistance of the shunt. For example, calling galvanometer 200 and shunt 80 ohms, then their sum, 280, divided by the shunt, 80, gives 3.5 as the multiplying power of the shunt of the particular coil in use. If a wire tested without the shunt, as above, gives a reading of 28 degrees on both poles, then 18,807 ohms, multiplied by 3.5, or 65,824 ohms, is the required resistance. A change of battery cells, or shunt resistance, will require a new calculation to obtain the power of the shunt.

Example of a test by station A to obtain the insulation resistance of a wire from A to B, 20 miles, and from B to C, 20 miles, total distance 40 miles.

With C open, A records a deflection of 20 degrees; with B open, a deflection of 10 degrees; then the insulation from A to B is 56,713 ohms, from A to C is 27,445 ohms. To calculate the insulation between B and C, note the tangents of the two deflections, thus:

20 degrees = 21
10 degrees = 10

and opposite 11 degrees (the difference between 10 and 21) we find 51,466 ohms. To obtain the insulation per mile, multiply the total insulation by the number of miles; thus total insulation from A to B, 20 miles, equals 56,718 ohms, making an average mileage of 1.184 megohm.

The conductivity measurements are made by placing the 200-ohm coil of the galvanometer in the bridge. Care must be taken not to use a large battery through a small resistance in the bridge, hence when the unknown resistance is between 1 and 100 ohms, the A and B sides of bridge should be 10 ohms and not over two cells of Callaud battery. Between 100 and 1,000, A and B 100 ohms; not over 20 cells. Over 1,000 ohms A and B 1,000 ohms; not over 100 cells. The battery key only to be depressed long enough to secure a steady balance of needle at zero.

All line wires which have been designated should be regularly measured for insulation and conductivity once a month and the results forwarded, on blanks supplied for the purpose, to the electrician's office.

Battery Tests.

All main batteries should be tested at the switch every morning, to see that they are in good order. Use the coil marked 0 and introduce resistance until the deflection on the tangent scale of the galvanometer is reduced one-half, viz., if needle points to 20 degrees bring it down to 10 degrees by inserting resistance. This resistance will be equal to the internal resistance of the battery. No office must be without a hydrometer and batteries must not be diluted with water below 15 degrees nor allowed to exceed 35 degrees. Oil should be used to prevent evaporation; the stands kept scrupulously clean and dry; the connections all firmly screwed up and the best gutta-percha wires used upon the coppers to prevent a short-circuit within the cell. It should be borne in mind that the battery is the most important part of the circuit and needs the very best attention.

F. W. Jones, Electrician.

THE RAPID CALCULATION OF MAGNETO-MOTIVE FORCES.

The mode of calculation adopted up to the present for the determination of the magneto-motive forces necessary to maintain a given magnetic flow in a circuit is generally somewhat complicated and laborious, for it takes into account permeabilities, magnetic resistances and magnetizing forces in C. G. S. units, whereas what we want to know practically is the magneto-motive force in ampere turns. M. Steinmetz's recent study of the law of hysteresis, writes M. Hospitalier in *L'Industrie Electrique*, has suggested to us the idea of simplifying these calculations by drawing up a table of the magnetizing forces necessary to produce a given induction in a magnetic circuit, the nature of which is known (air, soft iron, cast iron, etc.). This table gives the values of the magnetizing forces in ampere turns per centimetre, so that in order to determine in ampere turns the magneto-motive force, F, necessary to produce a given induction B, in a circuit of given length, l (in centimetres), all we have to do is to multiply the value of the magnetizing force, K, indicated in the subjoined table by the length of the circuit, l, in centimetres.

$$F = K\,l.$$

TABLE OF MAGNETIZING FORCES AS A FUNCTION OF THE INDUCTION.

Induction.	Magnetizing force K. In ampere turns per centimetre.		
B	Air.	Cast Iron.	Soft Iron.
1,000	800	....	..
2,000	1,600	....	....
3,000	2,400	....	....
4,000	3,200	4	....
5,000	4,000	8	1.6
6 000	4.800	17.2	1.95
7,000	5,600	33.6	2.3
8,000	6,400	64.0	2.7
9,000	7,200	101.6	3.2
10,000	8,000	150.4	4.0
11,000	...	233.6	5.2
12,000	....	....	6.8
13,000	....	....	9.6
14,000	...	....	13 6
15,000	....	....	22.8
16 000	....	....	41.6
17,000	....	....	84.0
18,000	....	....	160.0
19,000	....	...	280.0
20,000	....	....	....

Example.—We will take a dynamo, the air gap of which throughout its length is 2 centimetres thick (B = 3,000), the cast-iron inductors are 50 centimetres long (B = 8,000); and the soft iron armature is 40 centimetres long (B = 15,000); we have to determine the total magneto-motive force. We have:

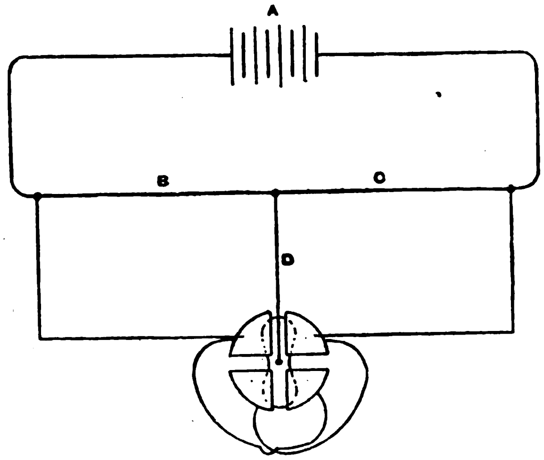
	B.	K.	l.	F.	
For the air gap...............	3,000	2,400	2	4,800	ampere turns.
For the field magnets........	8,000	64	50	3,200	"
For the armature...........	15,000	22.8	40	912	"
Total..................				8,912	

The magnetic constants determined by Dr. J. Hopkinson, when presented under this new form, give at once the numerical values of the magneto-motive forces necessary to overcome the individual magnetic resistances of each part of the circuit, and also show those upon which which we can act most effectively to modify the properties of the apparatus in view of a given result.

We think it will be of service to constructors of dynamos, motors, and transformers, to publish the above table, which will facilitate their calculations, as well as the sketching out of the characteristics as a function of the ampere turns of excitation.

THE COMPARISON OF VERY HIGH RESISTANCES.

Major Cardew has recently introduced the following method of comparing very high resistances, such as millions of megohms. Referring to the annexed diagram, A is a battery giving some 100 or 200 volts, B and C are two very high resistances. The quadrants of the electrometer are connected up as shown, the needle being connected to the point between B and C. If B is to be measured, C is altered until the needle comes to zero. It is then clear that the fall of potential over B is equal to that over C, so their resistances are equal. This method will show when two resistances are equal, however high they may be, provided they are low in comparison with the leakage resistance of the electrometer itself.



Comparing Very High Resistances.

MILITARY TELEPHONY.

During the monster military manœuvres which took place last autumn, in the east of France, the telephone was, by order of the Minister of War, made extensive use of. Batteries being inadmissible, magnetic telephones were alone employed; the receiver being fastened to the *képi*, while the transmitter was held in the hand. A combined receiver and transmitter (50 mm. diameter, 400 grammes weight) was also tried. A naked .6 mm. bimetallic wire was used with an earth return. A good earth was made by sticking a bayonet well into the ground. Mounted soldiers connected the earth wire to their horses' bridles, the current going to earth through the horses' hoofs. Two men formed a telephone detachment. One carried the telephones and a rolling drum weighing 2½ kilogrammes and wound with 1,000 metres of conductor; the other had a light bamboo stick, with a hook at the end and another drum of wire. The two men could thus lay 2 kilometres of line. The man with the telephones walked rapidly along unrolling his wire and his comrade followed and placed it as far as possible out of harm's way on branches, hedges, walls and along trenches. In one experiment a 23-kilometre line, with 10 intermediate posts, was laid down in five hours, speech was perfect, and the whole was taken up again in an hour. Earth contacts seemed to have but little influence. During the sham fight of September 7, a 12-kilometer line worked without a moment's interruption, although an entire cavalry division passed over it. The cost of the system need not be an obstacle, 10 kilometres of line, 10 drums, 3 telephones, and 5 bamboo rods only costing 185 francs.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XIII. NEW YORK, APRIL 13, 1892. No. 206.

It is often through failures that men learn how to succeed—Chauncey Smith.

RAPID TRANSIT IN BOSTON AND NEW YORK.

THE question of rapid transit in Boston is discussed very exhaustively in the report that has been made by the special commission appointed for the purpose. The difficulties in Boston, from the growth of population and the increase in travel, appear to be the same as they are in New York. Ten years ago, the steam railroads carried in and out 25,000,000 passengers per annum. In the year ended June 30, 1891, that class of travel had swollen to 51,000,000. In 1871, the street railways within the 10-mile circle carried 34,000,000 passengers; in 1881, the number was 68,000,000, and in 1891, it was 136,000,000. Evidently the travel doubles every decade, and the facilities for travel fail to keep pace with the needs of the city.

In order to supplement the great electric system of the West End Company, the Commission proposes an elevated road, reporting many objections to such an underground system as the Greathead tunnel; and it also recommends for the benefit of commuter or suburban travel great union depots on the north and south sides of the city. Both plans are directed to the purpose of making cross-town travel cheap and speedy. It is suggested by the Commission that the motive power for their elevated road would naturally be electricity.

Boston now has its report, and we shall be interested to see what becomes of it. We too in New York have a Commission and a report, but it is hard to see that we are getting along any further. To borrow Thomas Carlyle's phrase, we are merely "marking time", in face of one of the greatest emergencies of city life and growth. Not only is travel up and down town intolerably slow, except by infrequent, crowded expresses, but travel across town above 59th street can hardly be said to exist. All the way from that street up to 125th, there are practically no means of communication by street railways between the great populations of the east and west sides. Yet it would be easy enough to equip electric roads for the purpose, and it would be equally easy to equip up and down electric roads for rapid "rapid transit." Meanwhile, the starting of the cable road on Broadway will be but a slight mitigation of the evils now endured. That is no fault of the cable, for the same is true of the excellent electric service in Boston, and will be true of any surface methods. Swift city travel can only be had by elevated, depressed, or underground roads. Accelerated travel might be had on surface roads, by barring miscellaneous wheeled traffic and by providing bridges or sunken crossings for foot passengers. If that were done, electric cars could at once be speeded up to 15 and 20 miles an hour on ordinary surface street railway tracks, with an immense gain in the convenience of travelers; but no city appears willing to make any such arrangement or concession as that. "Speedways" are not in fashion.

THE GAS EXHIBIT AT THE WORLD'S FAIR.

WE note that our gas friends have been and still are not a little excited over the fact that gas has been slighted as an exhibit for the World's Fair at Chicago. This is a pity, and we can only say that for ourselves we should be glad to see a fine gas display made. Electric lighting has nothing to lose by the contrast, and even if it had, that is no reason why gas should be overlooked. But we must say that some of the gentlemen most prominently connected with the agitation to have gas represented are greatly misinformed on the subject. For example, we find Mr. A. C. Humphreys, of Philadelphia, writing to Director General Davis as follows:

> The gas industry upon the initiative of the World's Fair authorities received no recognition from those authorities. A rival industry, that of electric lighting, not only received recognition, but was assigned a most favorable position for its special exhibition building; and arrangements were made to pay for this building from the funds of the World's Fair organization. This building is designed to be complete and ornamental and covers a ground space of 343 feet by 690.

Now this statement may be well meant, but it is nevertheless all awry. The building in question is *not* intended for, nor will it be devoted to, electric lighting. Its name is "Electricity Building." There will be very little electric light apparatus in it. Probably not one-quarter of the space will be occupied by electric light specialties. Most of the space will be occupied by the telegraph, the telephone, the electric motor, the electric railway, electric bells, clocks, annunciators, burglar alarms, district messenger calls, fire alarms, medical appliances, torpedos, electric mines, batteries, switches, electrical instruments of endless variety, electrical books, electric relics, insulators, wires, cables, subways, cells, interior conduits, cigar lighters, electric filters and a multitude of other things. We think that in providing for this new and vast industry, now growing at such a tremendous rate, the Fair management did very wisely. The electric light is but a small part of the electrical field, and will come in for its share of the building, but no more. The management may use the light for general illumination purposes, but that is not the point in question, any more than their use of electric power during the work of construction. Our sympathies are with the gas interests in their desire for a good exhibit, but it really is a pity they are not better informed.

TAPPING UNDERGROUND MAINS FOR HOUSE SERVICES.

The intelligent observer, watching the developments and changes which have gone on for some time, both in the construction of apparatus and in the operation of central stations, cannot fail to have noticed the fact that in a large measure the day of the so-called "system" has passed. To put it another way, the art has arrived at such a state that numbers of independent workers and thinkers have begun to stamp individuality on their work, which though in many instances, it is true, built upon that of an original "system," nevertheless embodies modifications of distinct value. As a result we notice many differentiations in local practices. An example is brought out in the description, by Mr. Israel, of the method employed by the Edison Company in Philadelphia, in putting in house services from the street mains. Mr. Kortheuer had shown, in a previous issue, how the New York Edison Company effects the same object by means of solid iron tubing resembling in its general nature the tubing employed in the mains; but Mr. Israel points out that many advantages can be gained by the employment of conductors in lead tubes so that they can be bent to conform to irregular passages necessary to reach from the main to the house, thus avoiding all joints, elbows, couplings, etc. An interchange of methods and experiences as here outlined would, we are sure, often prevent needless variations from standard practice and yet add much to the stock of information valuable to central station men. Our columns are always open for any such communications.

THE MARVELS OF THE TROLLEY.

Here is one of the choicest efforts of the prize imbecile who edits plate-matter supplied to the evening papers in the suburban cities :

> **DANGERS OF THE TROLLEY SYSTEM.**
>
> Newark, N. J. April 4.—A furniture truck, drawn by three horses, which became frightened at an electric car on Central avenue, ran away, and dashed madly down the avenue. They ran into one of the poles that support the trolley wire, snapping it like a pipestem, and at the same time knocking a woman down. She was rescued in time to save her from the electric current, which ran along the ground for two blocks.

The careful reader will observe that it was the furniture truck that "ran away;" the horses, being more sensible, were merely "frightened" as they well might be, at the action of the vehicle. The prompt action of the unknown rescuer who dragged the woman from the path of the approaching electric current, which inundated, and doubtless completely submerged, the pavement "for two blocks," cannot be too highly commended. It was obviously one of those cases in which presence of mind was even more important than absence of body.

The Loss in Arc Lamps.

In his admirable paper read at Montreal, last year, Mr. James I. Ayer pointed out, among other things, the great necessity of maintaining accurate current regulation on arc light circuits, and showed how the variation of only a fraction of an ampere might lead to serious loss in the consumption of fuel, etc. But there is another source of loss frequently encountered in the operation of arc lamps, depending upon their construction and the nature of the cut-outs with which they are provided. This is shown by Mr. Widmayer in tests on both ten and four ampere lamps. With the former, the energy consumed in the lamps when the carbons have dropped together and the current thus passes through carbon stumps, spools, etc., may reach nearly ten per cent. of the total energy consumed by the lamp when in full operation; whereas, when completely cut out by the automatic cut-out, the loss may be reduced one-half. In the four-ampere lamp the loss is not quite so large, but still is sufficient to warrant attention to this detail. Attention to apparently small losses of this nature may lead to economies little dreamed of.

Electricity from Gas.

It may be shown by a very simple calculation that the cost by candle power of light as developed by the burning of gas directly in gas burners, compared with the cost per candle power developed in the incandescent lamp from a generator driven by a gas engine is considerably in favor of the latter, and when this comparison is made to apply to the arc light, the economy of the gas engine is self-evident. This fact has already been recognized to some extent by gas companies operating electric light lamps; not a few of them drive their dynamos by gas engines. A recent development in the combination of dynamos with gas engines for domestic purposes is, therefore, worthy of note, and the description which we give of such a combination, on another page, well shows how the general adoption of the multipolar dynamo makes it possible to apply the gas engine direct to the armature shaft without intermediate gearing of any sort.

New Electrical Apparatus.

A distinguished legal writer has observed that instructors of youth should strive "to suppress, with an equal hand, the ebullitions of stupidity, and the coruscations of true genius." It is nevertheless, not easy to say what should be done in some instances, with the ebullitions—or, if you please, the coruscations—of the secular press, when dealing with technical subjects. A transatlantic weekly newspaper in chronicling the various misdeeds of one Mason, who professed among other things, to have found out how to manufacture aluminum at two shillings per pound by a new electrical process, says that he was convicted of having obtained in furtherance of his project under false pretences, "a carsaw voltmeter and a gravity animator" from one firm, and "three animators" from another, not to mention divers other equally curious instruments. Meanwhile the "process" remains a deep mystery.

Wire Determination in Multiple Arc Distribution.

The nature of the work involved in most systems of distribution at constant potential is rarely such that a specific rule can be laid down for designing the plant so as to obtain the greatest economy in wiring, and the judgment of the electrical engineer must enter largely as a factor; but there are, nevertheless, certain general rules which can be applied as a check upon the work. Two rules of this kind, in very simple form, are given by Mr. J. Lester Woodbridge in our issue of this week, and they are of such a character that they can be readily applied.

GEARLESS MOTORS.[1]

BY S. H. SHORT.

AFTER a few remarks introducing his subject, the speaker continued as follows:

We will now take up the matter of the power lost in spur gearing, and see what we can gain in that direction by abandoning gears. When we first took up the subject of a gearless motor, we set about to see how much could be gained in the efficiency of transmission of power by doing away with the gears. I made a very careful and thorough investigation of the losses between the armature pinion and the intermediate gear, and between the intermediate pinion and the axle gear, of a double-reduction motor. I first put a double-reduction motor in good order, eliminating the armature bearing losses, as much as possible, by running the motor for a long time, to wear the bearings down to a good surface. I put my power brake for determining the horse power directly on the armature shaft and ran the motor, delivering different horse powers all the way from zero to its full output—20 h. p. At the same time we measured the electrical horse power which was being put into the motor, and from this we constructed a curve of efficiency of the motor at different loads, which curve is reproduced as the upper curve in Fig. 1. The greatest efficiency reached by this motor was about 70 per cent. at a load of from 14 to 16 h. p. The efficiency at small loads, say at 2 h. p., was something like 50 per cent.; at 4 or 5 h. p. an efficiency of 65 to 70 per cent.

We then took the brake from the armature shaft and replaced it with a well-made armature pinion, allowing it to mesh with a well-made intermediate gear, these gears being cut as nicely and as carefully as possible, so that there would be the least possible loss between the two. Putting the brake on the other end of the intermediate shaft, we again secured the same number of readings of the horse power delivered, after being passed through this one pair of gears, the electrical horse power being indicated carefully at the same time. From the efficiency at different horse powers thus obtained we produced a second curve, which is shown in Fig. 1 as the middle curve in the diagram, and found that the efficiency of this arrangement had fallen considerably. We once more removed the brake and placed the intermediate pinion on the intermediate shaft, allowing it to mesh with the axle gear. The brake was now placed on the axle itself and another set of measurements—the same as those before made, were secured, and a curve of efficiency again plotted, which showed a large loss in the gears, the efficiency at the axle being less than that at the armature by an amount indicated by the two outer curves. The axle results showed that at 14 h. p. delivered by the motor, we obtained an efficiency of 70 per cent. as a maximum when the brake was placed on the armature shaft. When the brake was placed on the intermediate shaft delivering 14 h. p. the efficiency dropped to about 62 per cent. When placed on the axle, the efficiency dropped to a little less than 55 per cent., showing a loss in the gears of some 15 per cent. when delivering 14 h. p. You will find in going over these curves that the loads vary considerably with the speed. Making an efficiency curve of the gears alone at different speeds, you will find the efficiency is very low at heavy loads and slow speeds and rises to its highest at medium speeds and medium loads, falling again when running up to higher speeds. For this reason it is more economical to run a geared motor not too fast or too slow, but at a medium speed. This fact has been established long since in the use of gears in other classes of machinery, and in designing machines where power must be transmitted through gears.

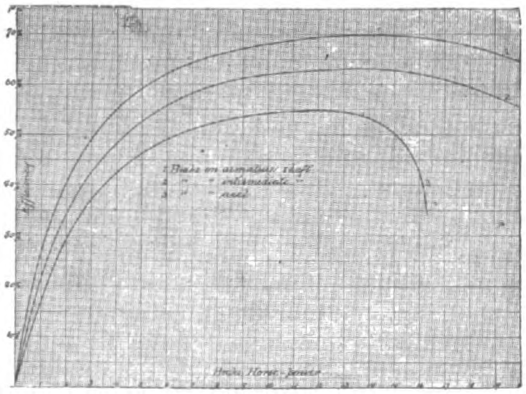
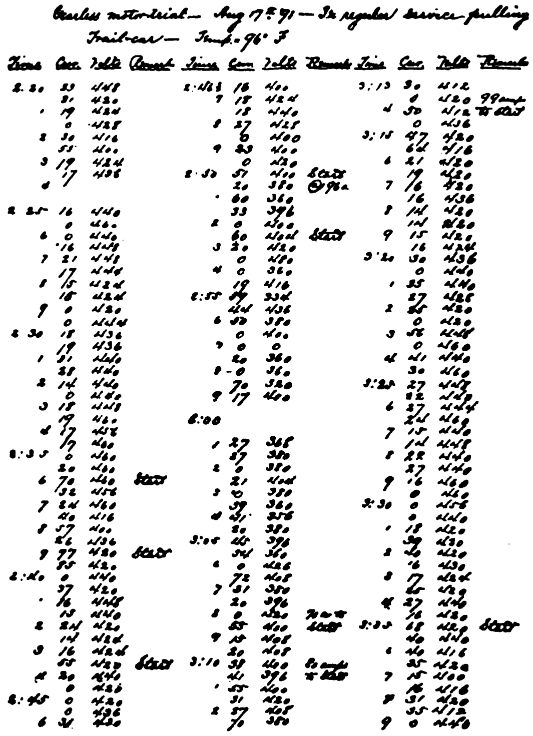


FIG. 1.

The best possible speed at which gears are to be run, and the relation between pinion and gear, are carefully considered. In the single-reduction motor we regain, we might say, more than half of this loss in efficiency, because the gears are run at a moderate speed. I think that this one feature of gear loss makes it desirable to abandon their use in street car motors if possible. If we can save in practice 15 or more, nearly 20 per cent. of the power consumed in operating a street car motor, by using the gearless instead of the double-reduction type, it is well worth while, as this means the consumption of less coal and the reduction of first cost in the power plant and accessories.

The actual weight carried by a set of wheels on the rails does not seem to affect the joints materially. Old horse cars, even when carrying heavy loads of passengers, do not affect materially the rail joints. Cable cars do not destroy their tracks, no matter how great their loads. Therefore it must be that this heavy weight of the motor carried solidly on the axle is the thing that is breaking down the rail joints on electric lines. This heavy jarring also crystallizes the axles, and we have complaints from all over the country that axles on motor cars are breaking. When we come to examine these breaks we find that the iron has crystallized, and the manufacturers are now endeavoring to overcome this by increasing the size of the axles. With the "gearless" motor, as we now construct it, none of the weight is directly carried on the axle. The wheels, not being very heavy, do not make a heavy blow, but by the time they have reached another portion of the rail the motor falls down against its springs, distributing the blow, as it were, over a considerable length of the rail, thereby preventing serious damage to the rail joint.



Gearless motor trial — Aug 17th 91 — In regular service pulling
Trail-car — Temp. 96° F

Time	Cur.	Volts	Remark
2.20	33	448	
	31	420	
1	19	424	
	0	428	
2	30	416	
	55	400	
3	19	424	
	17	436	
4	7		
2 25	16	440	
	0	460	
6	0	440	
	16	448	
7	21	448	
	17	444	
8	15	424	
	15	424	
9	0	420	
	0	444	
2 30	18	436	
	19	436	
1	31	440	
	38	440	
2	14	440	
	0	460	
3	18	448	
	19	460	
4	17	458	
	17	400	
2:35	0	460	
	20	460	
6	70	440	Start
	32	456	
7	24	460	
	40	416	
8	57	400	
	26	436	
9	77	420	Start
	85	420	
2:40	0	440	
	37	420	
1	16	448	
	15	440	
2	24	420	
	14	424	
3	16	424	
	55	420	Start
4	20	440	
	0	426	
2:45	0	420	
	0	436	
6	31	420	

Time	Cur.	Volts	Remark
2:46	16	400	
7	18	424	
	18	440	
8	27	428	
	6	400	
9	23	400	
	0	420	
2:50	51	400	Start
	20	380	@96a
1	60	360	
	33	396	
2	0	400	
	60	404	Start
3	20	420	
	0	480	
4	0	360	
	19	416	
2:55	19	334	
	44	436	
6	37	380	
	0	400	
7	0	0	
	20	360	
8	0	360	
	70	320	
9	17	400	
3:00			
1	27	368	
	27	380	
2	0	380	
	21	404	
3	0	380	
	39	360	
4	41	356	
	20	380	
3:05	45	396	
	34	360	
6	0	426	
	72	408	
7	31	380	
	20	396	
8	0	420	70 amp
	85	400	Start
9	15	408	
	20	408	
3:10	38	460	80 amp
	41	396	to start
1	55	400	
	31	420	
2	57	408	
	70	380	

Time	Cur.	Volts	Remark
3:13	30	412	
	0	420	99 amp
4	50	412	to start
	0	436	
3:15	47	420	
	64	416	
6	21	420	
	19	420	
7	16	420	
	16	436	
8	14	420	
	14	420	
9	15	420	
	16	424	
3:20	30	436	
	0	440	
1	35	440	
	27	428	
2	25	420	
	0	420	
3	56	448	
	0	460	
4	41	440	
	30	460	
3:25	27	448	
	22	448	
6	27	444	
	24	460	
7	15	440	
	14	448	
8	22	440	
	27	440	
9	16	460	
	0	460	
3:30	0	456	
	0	440	
1	18	420	
	39	430	
2	20	420	
	16	430	
3	7	424	
	25	420	
4	27	440	
	16	430	
3:35	68	420	Start
	40	440	
6	40	416	
	35	420	
7	15	400	
	16	416	
8	31	420	
	35	412	
9	0	440	

FIG. 2.

The question is often asked: How do you obtain the necessary power or tendency to turn the wheels around without using an abnormal amount of current in so doing? It is contended that in a geared motor we have an enormous leverage through the gears. If we had a small armature, the same as is used in the geared motors on the axle, we would not, of course, be able to start the car, or to do the work necessary in moving a loaded car, but we have a large armature placed in a very strong magnetic field, and we have a great many more turns of the same current around the armature, thereby gaining in two ways, a greater leverage because of a larger diameter of armature, and a greater pull at the end of that lever, because of the increased number of turns of wire on the armature and the stronger magnetic field.

We have the advantage in the slow-running motor, of practically doing away with the loss in Foucault currents set up in the armature ring. By designing our motor with a very low resistance of the magnetic circuit, we are able to cut down the wire on the machine so that its resistance is quite low, being only about 2½ ohms. There is another advantage in this slow-speed motor, which is not small; the wear on the commutator is very slight, and the heat produced by the friction of the brushes on the commutator is exceedingly small, making the motor run cool in all its parts. We are obliged, of course, to take advantage of everything that is possible in the construction of the gearless motor, in order to make it small and light enough for street car service.

To answer the question as to how much current is taken by the gearless motor in operating a car, we have prepared readings taken from a car in actual service, drawing a trail car. The current readings, also the pressure readings, were taken every half a minute, and from Fig. 2, a very good idea of the amount of current required can be gained. These readings were taken in August on the East Cleveland Railroad, Cleveland, Ohio. On this road the traffic is very heavy, although the grades are light, but by comparing these results with those obtained from single and double reduction, you will find that there is practically little or no difference between the current readings. The average readings, however, in the test run with the gearless motor, will be considerably lower than those with the geared motor, owing to the fact that we have gotten rid of the gear friction. The gearless motor will coast so easily that on a very slight down grade a car thus equipped will run up to speed, without any current being used, and in making stops the current is shut off from a gearless car long before it is in a geared motor car. These intervals of the use of little or no current as compared with the intervals in which there is little or no current used in a geared motor are very considerable, and represent the extra loss in the gears.

---

[1] Abstract of a paper read before the Chicago Electric Club, March 28, 1892.

We have carefully tested double reduction, single-reduction and gearless cars running on the same track, on roads in Cleveland, Ohio, taking at the same time readings of current and pressure, and we have found that in some cases the single-reduction would require the least amount of current, sometimes the double-reduction and sometimes the gearless, depending upon the number of passengers hauled, stops made, and other things that might come in to consume more or less power; so it is difficult for us to say that there is any difference in actual power consumption between the three classes of machines. The gearless motor is capable of starting loads as quickly as the geared motor, and is capable of starting as heavy a load under similar conditions, and we have a curve shown in Fig. 3 which illustrates the actual horizontal pull of a 20 h. p. gearless motor, mounted on 33-inch wheels. In examining this curve, it will be seen that the horizontal effort in pounds when the car is running 20 miles per hour, is 250. In ordinary street car practice, we find that it requires about 20 pounds per ton to move a load on street car rails. This means that with a horizontal pull of 250 pounds this single motor could move a car weighing 12 tons at the rate of 20 miles per hour, or, as the curve will show, that at 14 miles per hour, the motor has a horizontal pull of 700 pounds, or it will move a load of 35 tons, at the rate of 14 miles per hour on a level track. This curve is not falling off rapidly, certainly not as rapidly as it would with a geared motor, because the loss in the gears begins to increase very rapidly with the heavy loads. You can easily figure from this curve what the motor will do under any conditions of load, grade and speed. The tendency in street car practice is to increase the speed of the cars, and the gearless motor lends itself especially to this end, as we have found that with very rapid speed, geared motors wear out the running parts more rapidly and become very much more expensive to maintain; while the gearless motor can operate with as great economy at the slow pace required in crowded streets, it is also capable of running at a very much higher speed in suburban traffic without the slightest fear of damage to the machine. In this respect it makes a very much more flexible motor than the geared machines.

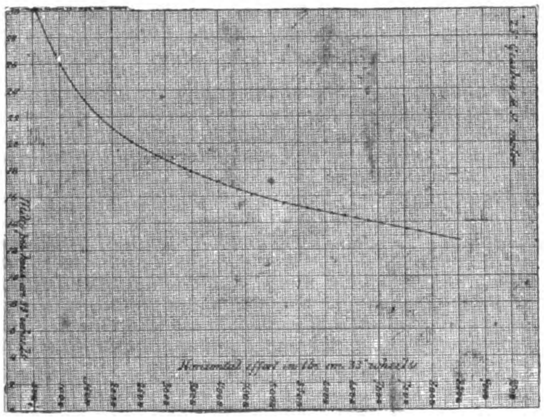


FIG. 3.

You can easily understand that this motor now makes it possible for us to develop large electric locomotives to be used in elevated railway service, and for pulling suburban trains in and out of large cities. From calculations and designs which we have made, we find that the size and weight of the motors required for 200 and 400 h. p. locomotives is not more than is necessary to produce the required adhesion to the rails needed for the required tractive pull to move these heavy trains. The motors are not large comparatively, and their economy will be very great. We believe that this branch of electric railroading will develop rapidly and that within a few years gearless electric railway motors will be used in places, for purposes and in numbers unthought of at the present time.

THE ELECTRIC INDUSTRIES OF NASHVILLE.

BY PROF. F. A. CHASE, FISK UNIVERSITY.

THIS is an inland city of about 60,000 people, and represents fairly well, probably, the progress of electric industries throughout the country. The earliest, of course, is the telegraph. The first line reached Nashville in 1847. The bulk of the business has been done by the Western Union, or its corporate progenitors. Its building having been burned about a month since, it is now doing business in temporary quarters. It has in use 11 quadruplex instruments, 2 duplexes and 25 single Morse sets. In the permanent building it will have a battery of about 5,000 cells. An estimate has been made on the cost of engine and generator, but it was decided that such a change could not be made with economy, until there was a demand for the equivalent of 10,000 cells. There is a district messenger system with wires running to the principal business offices. Dispatches are supplied to three dailies, and there is a business, including repeated messages, of about 200,000 dispatches a month. The Postal Telegraph-Cable Company does a local business in the city of 60,000 messages a month, besides about 20,000 relay messages.

The first telephone used in the city was made by J. W. Braid, from drawings given in the *Scientific American*. This was in September, 1877, and was attached to a line connecting three places in the city. The first commercial line was erected in December, 1879, between the furniture store of Messrs. Weakly & Warren and their factory in the suburbs. A company was organized about this time, an exchange office established, and the business rapidly extended. It now has 1,651 subscribers, who pay an average rental of $5 per month. Lines are extended to 14 sub-exchanges in the country about. For distances not exceeding 40 miles the charge is 25 cents, for longer distances up to the limit of 110 miles, the charge varies from 35 to 45 cents.

The vicissitudes that have marked the development of commercial electric lighting throughout the world have been typified by the changes that have characterized the business in Nashville. The first company was organized in 1881 with a capital of $50,000. This was in the days when it was supposed that there was only one firm in the country that could furnish a complete plant. There were reorganizations in 1885 and 1889. In 1890 the Thomson-Houston Company got the contract for lighting the city, and the original company bought it out, giving bonds to the amount of $200,000. The company is now about to be sold out to the Thomson-Houston, it is supposed, for non-payment.

It has 60 Thomson-Houston 50 arc dynamos, two old Brush dynamos—in use since 1881—one of 55 lights and the other of 28 lights, three Westinghouse alternators of 1,000 lights each, two Westinghouse of 150 lights each, one Thomson-Houston alternator of 1,000 lights, and one Thomson-Houston generator of 60 electric h. p. for motor work. The power is furnished by two Westinghouse 150 h. p. engines, two Ball of 60 h. p. and three Phœnix of 100 h. p. The boilers were made by the Phœnix and Erie City firms.

There are isolated plants in three hotels, three cotton mills, five flouring mills, one cotton-seed oil mill, two railroad shops, two parks and the water-works, all but three using the incandescent light alone.

The United Electric Street Railway was organized in February, 1890. The capital stock is $1,000,000. It issued bonds for the old street car franchises to the amount of about $1,500,000, for plant of about $1,000,000, which has since been increased to a total of $2,700,000. It has 52 miles of track, 63 motor cars (four more to be added), and 13 trail cars. The motor cars are from the following firms: Westinghouse, 4; Sprague, 20; and Thomson-Houston, 39. The current is supplied by seven Thomson-Houston and two Edison dynamos. Of the eight boilers six are from the Phœnix and two from the Taylor Manufacturing Co.

All of the eighteen lines converge at the public square, and vary from one to five miles in length. The fare is uniformly five cents. Transfer tickets are issued on all lines, so that passengers for the same fare may ride the whole extent of any two lines (except parallel lines going to the same district), averaging six or seven miles.

There is a smaller road running out to a suburb four miles distant. It has five cars and uses the Edison system. Though the line does not run in a thickly settled region, the investment is said to be paying fair profits.

There has thus far been but little development of the electric motor in small manufacturing establishments. There is also little electroplating. But the fact that the city electric light and the street car firms have shops where they do their own electric repairing shows the great increase of mechanics in this line of work.

There is one electric supply store having a stock varying from $5,000 to $8,000, kept by Mr. J. W. Braid, who also keeps a small force of hands at work in wiring buildings, putting in bells, annunciators and independent lighting plants.

A READER at one of the large universities writes us that THE ELECTRICAL ENGINEER is "growing in popularity with the students, which it justly deserves."

A NEW WIRT SWITCH.

THE ELECTRICAL CONSTRUCTION Co., Chicago, have just completed a very neat and successful piece of advertising work, which, while not original in design, is carried out on a scale beyond anything heretofore attempted. It consists of a sign built up of incandescent lamps, over 300 altogether being used. This is placed on the front of one of the large dry goods houses and has attracted thousands of spectators every night by its brilliant display.

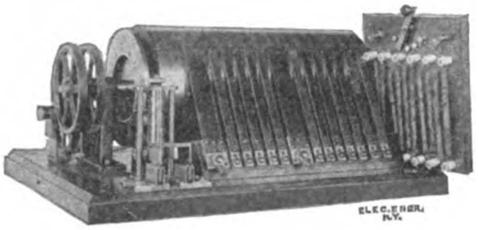


FIG. 1.—WIRT SWITCH FOR ADVERTISING SIGNS.

The accompanying illustrations, Figs. 1 and 2, are views of the automatic switch used to effect the combination of the different letters. A cylinder provided with copper contacts of varying extent is driven at a uniform rate by a small electric motor through a train of gearing. The separate copper springs bearing on this cylinder, one for each letter, throw them into circuit in succession, after which the operation of a cam at the end of the cylinder throws off the whole at one time. This arrangement prevents any sparking on the surface of the cylinder, as the contacts are made individually at this point, but broken collectively by the main switch. This switch is the design of Mr. Charles Wirt, of The Electrical Supply Co., Chicago.

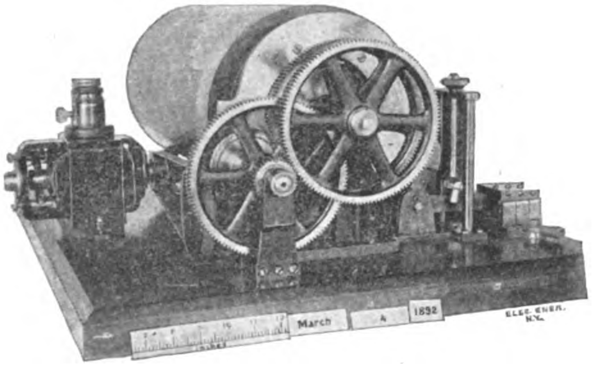


FIG. 2.—WIRT SWITCH FOR ADVERTISING SIGNS.

Letters to the Editor.

ENERGY BY THE ROOMFUL.

IN the article by Mr. Gordon, published in the *Nineteenth Century*, and reprinted on page 340 of THE ELECTRICAL ENGINEER, of March 30, referring to the modern conceptions of the nature of force, the author remarks:

> "Prof. Crookes has shown that the forces contained in this bombardment are immensely greater than any forces we have yet handled, many millions of horse power being contained in an ordinary room. Owing, however, to the forces being in every possible direction, they neutralize each other and no result of them is perceivable to our senses; but if ever we discover how to so direct their courses as to send the majority of them in the same direction, we shall have at our disposal forces as much exceeding any we are now acquainted with as the blow struck by a bullet exceeds the force required to pull the trigger of a gun."

As a curious illustration of the way in which different minds may sometimes be led to view a corresponding subject from the same point of view, permit me to quote from a pamphlet in my possession published now more than ten years ago by Chauncey Smith, one of the most eminent members of the Boston bar. Mr. Smith says:

> "The present scientific belief is that the atmosphere is an aggregation of infinitely small molecules, which really fill but a small part of the space the air seems to occupy; that through the unoccupied space these molecules are rushing at a high speed, hitting each other and the solid bodies around them and rebounding, and that what we call the pressure of the atmosphere, fifteen pounds to the inch, is really the bombardment of these molecules upon whatever arrests their course. The reason that all solid things are not swept away by this incessant pounding is, that the blows are struck in every direction, and so neutralize each other. But here is an ever-present and ever-active force, and if man should ever discover a way to make all the particles of a body of air move in one direction, he would have at every place on the surface of the earth an unlimited amount of power placed at his command."

FRANKLIN L. POPE.

Literature.

Die Elektrische Schweissung und Löthung. (Electric Welding and Soldering.) By Etienne de Fodor. A. Hartleben. *Vienna:* 1892. Paper, 5½ by 7½. 236 pages. Price $1.20.

ALTHOUGH much progress has been made in the domain of electric welding and soldering, the literature on the subject has been scattered through so many journals that the student desiring to make a systematic study of the progress of the art has up to the present been compelled to wade through many isolated papers and discussions. The volume before us is the first in which we are presented with a systematic treatment of various methods which have been proposed, or which have already come into practical operation.

A glance at the volume shows that electric welding and soldering has displaced not only hand processes in many instances, but that it has created more than one new industry. The already large list of inventors whose methods are described in this work shows that this field is one which has found active workers in many directions, and although it may be claimed by some that much that has appeared in electric metal working has proven impracticable, it cannot be denied that the actual work already accomplished is certain to be the forerunner of what will eventually turn out to be little less than a revolution in many metal-working processes. Naturally the work of Prof. Elihu Thomson occupies a prominent position in the volume before us, and the descriptions of his various machines and processes form several interesting chapters. We also find descriptions of methods employed by Benardos, Coffin and others in the applications of the arc for the welding of metals and various other processes due to Burton, Lieut. Wood and others. The author has collated also very full data on the results of electric welding relative to the mechanical strength of the finished product. The book will afford interesting reading, not only for the electrical and mechanical engineer, but for all interested in technical work. The illustrations throughout are very clear, and we note, with pleasure, that the author gives frequent references to original sources, and includes a very complete index.

Telephon, Mikrophon und Radiophon. By Theodore Schwartze. Third edition. A. Hartleben. *Vienna:* 1892. Paper, 5¼ by 7½. 253 pages. Price $1.20.

THIS work, constituting one of the first in the Electrotechnische Bibliothek series has been revised and now gives a well-connected history of the telephone and describes various forms of telephones, microphones and radiophones. The work lacks, somewhat, the details of more modern American practice, which, however, may be pardoned from the fact that this practice has been very largely withheld from publication. The chapter on the phonograph, with which the book ends, does not show the most recent form of that instrument. The author still confines his description to the old tinfoil cylinder; his remark, therefore, that the phonograph has not reached a state of practical importance is based on the assumption that the instrument has received no improvements on its first form, an assumption which it is needless to say is not borne out by facts.

L'Annee Electrique. By Ph. Delahaye. 7th year. Baudry & Co. *Paris:* 1892. 4¾ by 7½. Price, $1.00.

THESE annual volumes, containing the progress of each year preceding their issue, are too well known to require any special notice. We may merely remark that the author has carefully noted the principal events of the year in all departments, so that the reader is afforded, within a small compass, an epitome of the year's work.

Harmonized Melodies. Arranged by Charles D. Blake. *Boston,* F. Trifet, 408 Washington street. 256 pages, 12 x 9 inches. Price, boards, $1.; cloth, $0.60.

BY presenting to the musical world a collection of 400 songs, giving not only the words and solos, but all the instrumental accompaniments complete, the publisher of "Harmonized Melodies" has preserved for modern use scores of the most popular old and new songs of our century.

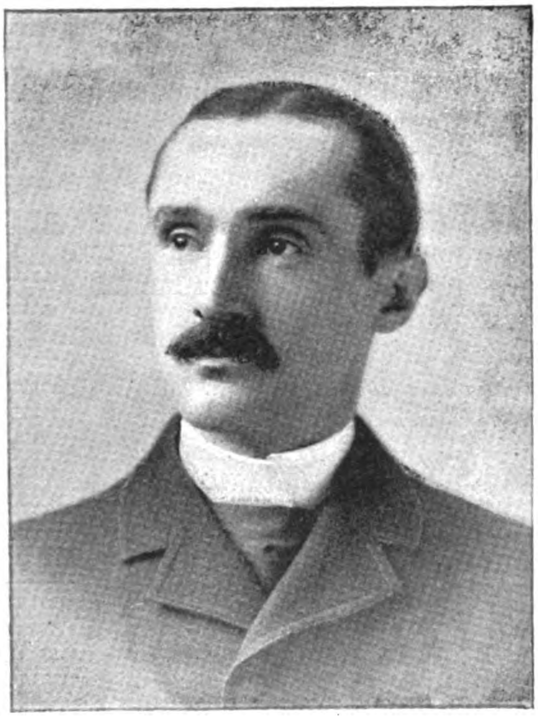
The arrangement of the music is a special feature of the volume, and is the work of Mr. Charles D. Blake, the eminent Boston composer, which fact alone speaks volumes, while the name of the publisher is another indication of the value of the book.

Personal.

S. M. HAMILL.

Mr. S. M. Hamill, recently elected secretary and general manager of the Brush Electric Company, is a conspicuous example among the large number of relatively young men who have achieved positions of prominence in the electrical industry.

Born in Lawrenceville, N. J., he prepared at the Lawrenceville School for Princeton College, where he was graduated in 1880 with the degree of B. A. He has since received the degree of A. M. After leaving college he taught for three years in the Lawrenceville School, during a portion of which time he studied law. Having a desire for active business pursuits, and determined to go to work, he secured, in 1884, a position as clerk on the freight platform of the Chicago, Burlington and Quincy Railway Company, in East St. Louis, and subsequently became private secretary to the agent, clerk in the paymaster's office, and in the first vice-president's office in Chicago. In 1886 he was in charge of the large grain elevators owned by the Chicago, Burlington and Quincy Railway Company, in Peoria, Ill., from which place he went to Cleveland to accept the position of assistant secretary of the Brush Electric Company. In 1889 he was elected secretary and moved to New York, where for three years he had charge of the general Eastern business of the company. During that period his business relations brought him general acquaintance in New York and the respect of all with whom he came in contact. At the last annual meeting of the Brush Company he was elected a director, secretary and general manager of the company.



S. M. Hamill.

Mr. Hamill is also president or secretary and director in a number of local electric light companies, and at present receiver of an electric company in Pittsburgh, Pa. While in Princeton he was one of the founders of the Ivy Club, and is a member of the Electric and University Clubs of New York and of the Electric and Union Clubs of Cleveland.

Mr. Hamill's successful career, although now covering only twelve years, well illustrates the mere utility of education—general training of the mind—to one of native capacity; to say nothing of its value in developing the graceful and genial qualities of mind and heart which have made friends of all his acquaintances.

Mr. George L. Colgate, E.E., has taken charge of the electric light and power plant at Roanoke, Va., which now has a capacity of 5,000 incandescents, and has begun to operate arcs. The plant now runs continuously except between 10 A. M. and 1 P. M., on Sundays.

Society and Club Notes.

MONTHLY DINNER OF THE BOSTON ELECTRIC CLUB.

The Boston Electric Club held its second dinner of the season at Young's Hotel, on Wednesday evening, the 6th instant, President Cram presiding. About fifty members and friends sat down to the dinner, which was a marked success in every way. Mr. William Stanley, Jr., was the guest of the evening, and afterwards read a most interesting paper, devoted to a profound discussion on the marvelous properties of ether as the medium for transmission of every form of energy. After the paper a number of questions were asked by various members of the club, and promptly answered by Mr. Stanley. A thoroughly enjoyable and profitable evening was spent, and it is to be hoped that these dinners will be held regularly in the future, and that members will assist by their attendance.

At the conclusion of the dinner, the president introduced Mr. Wm. Stanley, Jr., who spoke on the universal medium, the ether, especially in its relation to the propagation of electrical impulses and waves. While experimental evidence at first seemed contradictory the result of many experiments and observed phenomena led to the inevitable conclusion that the entire universe is filled with something which forms the highway over which all energy whether as heat, light, electricity, magnetic or chemical action is conveyed. This medium though extremely dense and of perfect elasticity was nevertheless so constituted that it permeated all matter, passing through solid bodies much in the same fashion as air passes through gauze.

To illustrate the method of propagation of impulses through the ether, Mr. Stanley pictured to his hearers a tube of some perfectly elastic material enclosing ether, reaching between Boston and New York, branching out at the latter place so as to act respectively upon a thermometer, a man's eye and a bottle containing hydrogen and chlorine. If now at the Boston end we began to deliver blows at an ever-increasing rate upon the cap closing the end of the ether tube, the first effect noticed at the New York end would be a rise in the thermometer, indicating an increse in temperature. As the rate of the blows was still further increased the man's eye would perceive light, beginning with red and passing through the various colors of the spectrum to violet; till finally at a still higher rate of vibration of the ether due to the blows chemical action would take place causing the hydrogen and chlorine to combine to form hydrochloric acid.

To form some idea as to the manner in which current is conveyed in a conductor, we might conceive, for instance, that an alternate current generator was a device which, when connected to the ether contained in the wire gives it a peculiar screw-like thrust in alternate opposite directions. These cause the ether in the wire to be driven or compressed in the direction of the length of the wire, and this compression may be thought to represent a flow of current.

Each impulse conveyed to the wire is radiated outward into space, so that if we could make an alternator that would twist the ether 400 or 500 billion times per second, we would radiate light from the conductor, or in other words the conductor would be luminous. Mr. Stanley thought it possible and highly probable that in the future we shall discern the means of producing a sufficient number of alternations per second to cause special apparatus through which they are made to pass to glow with waves of light without accompanying heat. The investigations of Mr. Tesla and the researches of many investigators make this result probable, and when that time comes, light will be the cheapest force at command.

A few years ago, said Mr. Stanley, we inadvertently conceived that we *made or generated* electricity; to-day we consider that the universe is an infinite sea of energy in which all matter is but incidental, all bodies but temporary or momentary constructions through which or by which this unseen energy may become apparent to our senses.

GRANT MONUMENT ASSOCIATION.

The following gentlemen have been named to act as members of committees representing the electrical industries, co-operating with the Grant Monument Association, in common with every other interest in the city. The amount required to finish Grant's monument and tomb on Riverside drive is $350,000, and the cornerstone is to be laid by President Harrison on April 27, with imposing ceremonies. Foundations of granite 10 feet high have already been laid:

Telegraph—Thomas T. Eckert, chairman; A. B. Chandler, James Brown. *Fire Alarm and Police Telegraph*—Joseph Stover, chairman; J. S. Morse, P. N. Ramsey. *Electrical Supplies*—E. S. Greeley, chairman; H. B. Thayer, J. H. Bunnell. *Electric Light Companies*—Henry Villard, chairman; C. J. Canda, A. D. Dorman, George W. Hebard. *Telephone Interests*—David B. Parker, chairman; Charles Dutton, W. D. Sargent. *Burglar Alarms*—

E. Holmes, chairman; Frederick Pearce. *Electrical Press*—C. W. Price, chairman; W. J. Johnston, Joseph Wetzler. *Electricians*—F. L. Pope, chairman; H. W. Leonard, George d'Infreville. *Electrical Protection*—E. Holmes, chairman.

Legal Notes.

A STORAGE BATTERY DECISION IN FAVOR OF THE ACCUMULATOR CO.

ANOTHER aspect to the interminable storage battery litigation is given by Judge Coxe, in the United States Circuit Court, who filed a decision on April 9 in the suit brought by the Accumulator Company, the owners of the Swan patent, against the New York & Harlem Railroad Company, to restrain them from using the Swan perforated plates in the storage batteries by which the electric cars which ran over the city route of the 4th avenue road were propelled. The decision was in favor of the Accumulator Company.

The suit was defended by the Consolidated Electric Storage Company, which controls the Brush patents that relate to the "active material," and that have been sustained so broadly.

Judge Coxe said, in rendering his decision, that he was sustained by many previous similar decisions in suits of this nature. In every case where suit has been brought by the owners of the Swan patent they have proved conclusively their exclusive right to the grid or perforated electrode.

Reports of Companies.

ANNUAL REPORT OF THE THOMSON-HOUSTON ELECTRIC CO.

THE annual meeting of the stockholders of the Thomson-Houston Electric Company was held in Middletown, Conn., on Monday, the 11th instant, when the accompanying statement was presented and the following directors elected for the ensuing year: H. A. Pevear, C.A. Coffin, J. N. Smith, B. F. Spinney, Chas. H. Newhall, S. A. Barton, Eugene Griffin, S. E. Peabody, T. J. Coolidge, Jr.

The report presented is given herewith in full. It was prefaced by a little introductory statement by Mr. C. A. Coffin, first vice-president, and accompanied by a number of tables bearing on the growth of the business. Mr. Coffin called attention to the depression general in 1891, and said that during the first half of the year, the gross and net business of the company fell off 30 per cent. This was, however, almost wholly made up in the second half, and at the date of the report, February 1, 1892, the orders on hand were more than double those at the same period in 1891. The business from the Boston office was $10,304,580 or about $100,000 more than in 1890. Mr. Coffin also referred to the decision sustaining the Brush double-carbon lamp patent, and pointed to the great growth in the number of local lighting companies and street railway companies. He also referred to the good fortune of the company in marketing local company securities at good prices through the United Electric Securities Co. Mention was also made by Mr. Coffin of the good work of the new purchasing department, the new meter department handling the Thomson recording wattmeter, and the promising development of electric locomotives for heavy work. The statement of profits and loss surplus account showed $1,524,414.25 addded to surplus from profits in 1892, making a total surplus of $7,546,947.96. The addition for 1892 is after paying 7 per cent. dividends on preferred and quarterly dividends at the rate of 16 per cent. on common.

LOCAL COMPANIES USING THE THOMSON-HOUSTON SYSTEMS.

	No. of Co's.	No. of Arc Lamps.	Incandescent Lamps.
January 1, 1883	5	365	
" 1, 1884	31	2,478	
" 1, 1885	59	5,867	
" 1, 1886	100	13,227	
" 1, 1887	171	21,840	11,275
" 1, 1888	303	36,936	59,330
" 1, 1889	419	51,621	120,380
" 1, 1890	587	68,203	281,555
" 1, 1891	755	87,131	616,355
" 1, 1892	873	100,293	806,500

RAILWAY COMPANIES USING THE THOMSON-HOUSTON SYSTEM.

	No. of Co's.	No. of Cars.	Miles of Track.
January 1, 1890	92	701	420.29
" 1, 1891	145	1,532	1,159.81
" 1, 1892	204	2,769	2,363.63

BOSTON, March 29, 1892.

The condition of the Thomson-Houston Electric Company, as disclosed by the Balance Sheet at the close of the last fiscal year, is respectfully submitted herewith.

The Liabilities, as shown in the statement, do not include $500,000 Thomson-Houston Collateral Trust Bonds, which were issued in 1889 as an accommodation to the Manhattan Electric Company of New York. The Manhattan Company, besides assuming the entire burden of paying the principal and interest of these bonds, supplied the Thomson-Houston Company, without cost to it, with ample collateral security for the same.

The Thomson-Houston Electric Company has received from its stockholders from time to time, $10,500,000 in actual cash from subscriptions to its common and preferred stock. The last issue of common stock, amounting to $1,500,000 at par, was sold in September, 1890, at 100% premium, yielding to the treasury $3,000,000 in cash.

Thus $1,500,000 of the surplus of the company on Feb. 1, 1891 ($6,022,533.71), is represented by premium received from the sale of common stock; the balance by accrued surplus earnings of the company.

The surplus net earnings for the fiscal year just closed, after deducting $1,236,366 paid during the year as dividends on common and preferred stock, is $1,524,414.25, making the total surplus, Feb. 1, 1892, $7,546,947.96.

Prior to March 1, 1892, there had been paid to the stockholders in cash dividends a total of $1,731,131.88. In addition to this, there had been distributed among the stockholders as a special dividend $1,000,000 of common stock at par, which was taken from the surplus account of the company April 15, 1889, and securities of the par value of $2,416,468.27 were placed in the hands of trustees for the benefit of the stockholders of the company, Oct. 5, 1889.

There has also been sold to trustees for the further benefit of stockholders of the parent company, stocks and bonds of local companies, classed as Thomson-Houston securities, series "A," "B," and "C," from which the shareholders have realized as profit, in excess of cost to them, an amount which, added to the present market value of the shares, would aggregate $775,000.

THOMSON-HOUSTON ELECTRIC COMPANY.

Balance Sheet, January 30, 1892.

ASSETS.		
Accounts Receivable, Mdse	$6,601,298.03	
Less Deductions, 10% (*a*),	660,129.30	$5,941,168.73
Notes Receivable	1,636,800.85	
Less Deductions, 7½% (*b*)	122,760.03	1,514,040.82
Cash		1,727,276.16
Real Estate, about 70% of cost		430,241.24
Machinery and Tools, about 60% of cost		491,044.53
Office Furniture and Fixtures (*c*) Cost $27,334.23 (charged off)		
Patterns and Models		135,000.00
Patents { Expense for the year charged off } (*d*)		338,854.29
Local Co.s' Stocks, 35% of par (*e*)		473,586.60
Local Co.s' Bonds, 70% of par (*f*)		1,858,570.00
Manufacturing Co.s' Stock, at cost (*g*)		8,729,195.50
Construction Co.s' Stock, at cost (*g*)		1,210,750.00
United Securities Co.s' Stock, at cost		525,420.00
Consignments		32,116.79
Merchandise Inventory, Factory (*h*)		1,731,481.55
Merchandise Inventory, Ry. Supply Dept		72,593.23
Merchandise Inventory, Ltg. Supply Dept		52,613.63
		$20,263,447.57
LIABILITIES.		
Capital Stock—Common		$6,000,000.00
Capital Stock—Preferred		4,000,000.00
Accounts Payable—Merchandise		498,808 24
Notes Payable—Collateral		1,429,486.14
Notes Payable—Unsecured		587,005.23
Mortgage		1,200 00
Guarantee Account (from accrued surplus)		200,000.00
Surplus February 1, 1891		6,022,533 71
Profits for the year	2,760,780.25	
Less dividend paid during the year	1,236,366.00	1,524,414.25
		$20,263,447.57

STATEMENT OF SURPLUS ACCOUNT.

Surplus February 1, 1891	$6,022,533.71	
Income for year ending January 30, 1892, after deducting dividends paid during the year	1,524,414.25	
Surplus January 30, 1892		$7,546,947.96

BENJ. F. PEACH, JR.,
First Assistant Treasurer.

In explanation of the deductions made from the assets of the Company, it may be stated that following the conservative policy that has always prevailed, allowances have been made with an idea of placing upon each and every asset a value which will be safe in any contingency.

(*a*) From Accounts Receivable, the same deduction has been made as in former years. This has in previous years always been found ample.

(*b*) The deduction of 7½ per cent. from notes receivable is 2½ per cent. in excess of the rate deducted in former years, and is regarded as more than a sufficient guarantee for contingencies.

(*c*) Following the precedent of last year, the expense incurred for office furniture and fixtures during the year has been charged to expense account.

(*d*) While a large sum has been expended during the past year in the acquisition of patents, this has all been charged to current expense instead of adding to the patent account.

(*e*) In local companies' stocks a deduction of 65 per cent. is made, which is 5 per cent. in excess of deductions in former years. More than $200,000 of stocks and bonds of railway and lighting companies at par value are carried in a separate account as of doubtful, though of considerable prospective value, and do not appear in the inventory at all.

(*f*) These bonds are nearly all payable in gold, and are amply secured by sinking funds and other protective provisions, made under the supervision of competent attorneys of our own selection. A large profit should be realized from the sale of these bonds.

(*g*) The Manufacturing and Construction Companies' stocks are taken at their cost value. The companies represented by these stocks are making very satisfactory earnings and working in harmony with the Thomson-Houston Co., thereby contributing largely to the success of this company.

(*h*) The inventory of merchandise and material at the factory has been taken in the usual way, *at less than actual cost.*

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MARCH 29, 1892.

Accumulators :--

Storage Battery Plate and Process of Making the Same, W. W. Donaldson and R. Macrae, 471,538. Filed Aug. 18, 1891.

Claim 1 follows:

A storage battery plate having perforations through both the active and inactive material and a space between the adjacent inner surfaces of the active material.

Secondary Battery, C. F. Winkler, 471,590. Filed Nov. 8, 1890.

The plate consists of a series of lead troughs placed one above the other and containing the active material.

Secondary Battery Electrode, C. F. Winkler, 471,591. Filed June 26, 1891.

Similar to 471,590.

Secondary Battery, C. F. Winkler, 471,592. Filed Sept. 29, 1891.

Employs a grid of insulating material capable of being made very light in weight.

Alarms and Signals :—

System for Transmitting Signals, H. A. Chase, 471,584. Filed Nov. 27, 1891.

A system in which one wheel may transmit its signal without additions, subtractions, repetitions or change of character over two different paths for two different purposes.

Automatic Guest Call, W. H. Perry, 471,686. Filed May 9, 1890.

Automatic Electric Fire Alarm, L. G. Woolley, 471.929. Filed Dec. 14, 1891.

Electrical Annunciator, N. M. Watson, 471,986. Filed Jan. 2, 1891.

An annunciator which does not require restoring after indicating the call.

Electrical Annunciator, N. M. Watson, 471,987. Filed Aug. 17, 1891.

Provides means for showing from which of two push buttons a call is being made.

Conductors, Conduits and Insulators :—

Insulated Electric Conductor, J. B. Williams, 471,587. Filed July 10, 1890.

Employs an exterior insulating layer and an intermediate corrugated covering, the poles of which form with the exterior layer the walls of continuous air passages.

Insulated Electric Conductor, J. B. Williams, 471,588. Filed Apr. 9, 1891.

Similar to No. 471,587.

Joint for Electric Wires, R. H. Smith, 471,625. Filed Aug. 24, 1891.

A screw coupling for trolley wires.

Dynamos and Motors:—

Dynamo-Electric Generator or Motor, C. W. & L. B. Atkinson, 471,691. Filed Aug. 18, 1891.

Provides means for enclosing brushes and commutators so that the machine may be worked in the presence of inflammable or explosive gases.

Dynamo-Electric Machine or Motor, W. T. Goolden & L. B. Atkinson, 471,-693. Filed Aug. 18, 1891.

Similar in its object to 471,691.

Commutator Brush, R. Hirsh, 471,792. Filed Oct. 29, 1891.

The brush consists of a number of strips each independently coated with a film of electrically deposited metal, the whole being then united by means of a second film.

Brush-Holder for Electric Motors or Dynamo-Electric Machines, C. A. Hussey, 471,819. Filed May 6, 1889.

Galvanic and Thermo-Electric Batteries :—

Galvanic Battery, W. Burnley, 471,945. Filed June 18, 1891.

A dry cell battery in which the negative element is enclosed within a porus cup in which a depolarizing compound is packed, the exciting composition. forming a layer between the open lower end of the porous cup and the bottom of the outer zinc jar.

Lamps and Appurtenances :—

Manufacture of Incandescent Electric Lamps, F. S. Smith, 471,576. Filed Dec. 22, 1890.

Employs leading-in conductors of iron upon which the glass of the enclosing chamber is fused, and a cement surrounding the iron wires at the point of entrance.

Support for Electric Lamps, C. J. Klein, 471,645. Filed Dec. 1, 1890.

Provides means for attaching lamps of different makes to the same support.

Mast-Arm Switch for Electric Lamps, T. Dillon, 471,730. Filed Nov. 4, 1891.

Bracket for Incandescent Electric Lamps, J. G. Goehst, 471,732. Filed Mar. 9, 1891.

Support for Electric Lights, J. J. Walsh, 471,837. Filed Sept. 15, 1891.

Electric Light Crane, J. Gallagher, 471,968. Filed July 13, 1891.

Miscellaneous :—

Governor for Marine Engines, E. F. Wallgren, 471,725. Filed Dec. 8, 1891.

Employs a throttle valve electrically actuated through the medium of a float.

Pole for Supporting Electric Wires, J. H. Huntress, 471,759. Filed Oct. 24, 1891.

Electric Telpherage Apparatus, M. W. Hassan, 471,790. Filed Dec. 29, 1890.

An electrical apparatus for the rapid transit of small packages.

Determining the Temper of Iron or Steel, C. A. Casperson, 471,809. Filed Sept. 19, 1891.

Consists of conducting electric currents through the pieces to be tested and simultaneously through another piece whose temper is known and conducting the heat developed by the currents to the thermometers.

Electro-Therapeutic Electrode, H. Bonis, 471.850. Filed Aug. 10, 1891.

Electric Lock, J. G. Thompson, 471,913. Filed Aug. 12, 1891.

Electrically Controlled Trap Door, F. C. Callahan, 471,947. Filed Dec. 14, 1891.

Endoscopic Instrument, J. W. Daily, 471,990. Filed Oct. 14, 1891.

Valve Controller, N. E. Nash and G. A. Eddy, 471,999. Filed Nov. 20, 1890.

An automatic electric controller for steam engine valves.

Method of and Apparatus for Producing Musical Tones by Electro-Magnetism, E. C. Ohmart, 472,019. Filed April 28, 1890.

Railways and Appliances :—

Electric Railway, W. C. Goss, 471,543. Filed Apr. 3, 1891.

Consists in improvements relating to the housing which incloses the supply conductor and its combination with the rail beds and supply conductor.

Device for Transmitting Motion, G. S. Strong, 471,655. Filed May 29, 1891.

A fluid-valve for electric street car motors.

Device for Transmitting Motion, G. S. Strong, 471,656. Filed May 29, 1891.

Similar to 471,655.

Switches and Cut-Outs :—

Electric Switch, H. Hubbell, 471,612. Filed Oct. 5, 1891.

An inexpensive, quick-acting switch.

Electric Switch, C. G. Perkins, 471,760. Filed July 24, 1888.

An electric switch in which power is stored by the turning of a shaft and afterward released by the withdrawal of the detent.

Reciprocating Snap-Switch, J. S. Gibbs, 471,993. Filed July 3, 1891.

Automatic Electric Cut-Out, E. A. Manship, 471,997. Filed June 30, 1891.

Employs a pawl adapted to hold the switch in a closed position, a solenoid, a core therefor and adjustable extensions.

Telephones and Apparatus:—

Telephone Receiver, J. A. Christy and E. J. Baldwin, 471,535. Filed Mar. 16, 1891.

Employs a system of perforated magnetic tubes in the chamber of the receiver connected to the actuating electromagnet and extending up to the diaphragm.

Attachment for Telephones, J. E. Hills, 471,549. Filed Apr. 27, 1891.

Telephone, J. H. Howard, 471,745. Filed Sept. 21, 1891.

A simple arrangement of the magneto box by means of which the necessity of making connection through the hinges at the front of the box is obviated.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS, ISSUED APRIL 5, 1892.

Alarms and Signals :—

Electric Indicator for Railroad Blocks, R. W. Jaggard, 472,359. Filed April 6, 1891.

Annunciator, W. C. Dillman, 472,439. Filed Dec 22, 1891.

An annunciator for use in connection with a speaking tube.

Annunciator, W. C. Dillman, 472,440. Filed Dec. 22, 1891.

Similar to No. 472,439.

Electrical Indicator, J. W. Henderson, 472,500. Filed Nov. 18, 1885.

Provides means whereby various portions of a distant moving object may be automatically indicated.

Conductors, Conduits and Insulators :—

Compound for Insulating Electric Wires, L. Hill, 472,352. Filed July, 11, 1891.

Consists of pittizite pitch, candle tar, coal tar, asphalt pitch, and rosin.

Distribution :—

System of Electrical Distribution, W. Marshall, 472,193. Filed Feb. 28, 1891.

System consists in carrying a direct current for a long distance over a small wire, the distribution being effected by means of condensers and the circuits being controlled and operated by a quick-acting switch or commutator.

Production and Distribution of Electricity, W. Marshall, 472,379. Filed Nov. 23, 1889.

Consists in alternately charging a condenser and throwing into the line beyond the condenser the currents of the condenser and the electric source; these acts being performed with such rapidity that the effects in the line appear continuous.

Galvanic and Thermo-Electric Batteries :—

Thermo-Electric Element, E. N. Dickerson, 472,037. Filed Feb. 27, 1890.

Consists of a series of parallel plates of different metals held firmly in contact with each other and adapted to be heated at one end.

Thermo-Electric Battery, R. J. Gülcher, 472,261. Filed June 18, 1891.

An improved form of the Gülcher thermopile.

Lamps and Appurtenances :—

Rheostat, J. R. Masury, 472,062. Filed June 20, 1891.

A rheostat for use in connection with incandescent lamp circuits.

Electric Arc Lamp, J. A. Mosher, 472,064. Filed June 20, 1891.

Has for its objects to provide an all-night lamp using a single carbon only and at the same time to decrease the length of the lamp.

Electric Arc Lamp, S. W. Rushmore, 472.274. Filed July 27, 1891.

An arc lamp for incandescent circuits in which the feeding of the carbon depends partly upon the operation of a coil in series with the arc.

System of Arc Lighting, H. A. Foster, 472,346. Filed Jan. 29, 1891.

Has for its object the protection of the exposed conductors and complete isolation of the operating parts of the system for the purpose of safety.

Adjustable Armature for Electromagnets, E. Hofmann, 472,480. Filed Sept. 22, 1891.

An armature adjustable with relation to its magnet without destroying the proper relation between the two. Adapted to the operation of arc lamps.

Automatic Electric Lamp Lighter and Extinguisher, J. H. Caughy, 472,494. Filed Nov. 17, 1891.

A time switch for electric lights.

Measurement :—

Galvanometer, S. Bergmann and G. A. Scott, 472,026. Filed Feb. 25, 1891.

Claim 1 follows:

In an electric meter the combination of a magnet, a metal strip longitudinally curved and gradually widened from one end to the other and supported adjacent to the pole of said magnet, and a weight or its equivalent for moving the strip in the reverse direction to that in which it would be moved by the magnet.

Electrical Meter, J. F. Kelly, 472,265. Filed Aug. 18, 1891.

A coulomb meter, consisting of a motor having a constant field, a shunt around the terminals of the motor, a load consisting of a fan or other device and means for indicating the revolutions of the shaft.

Miscellaneous :—

Fare Register, C. B. Cushman and H. G. Canfield, 472,085. Filed Oct. 2, 1891.

Carbon Holder, H. Howard, 472,055. Filed Oct. 21, 1891.

Carbon holder for electric welding machines.

Lightning Arrester, E. G. Miller, 472,135. Filed Aug. 27, 1890.

A helix having a mercury switch at the bottom and a movable armature for displacing the mercury.

Process of Decorating Glass, J. H. Scharling, 472,230. Filed July 1, 1891.

A system of decorating glassware by electroplating directly upon the glass, which is first washed with a solution of metallic salts.

Electric Recording Device for Compasses, C. L. Jaeger, 472,134. Filed April 14, 1891.

Brush Holder, J. R. Coffman, 472,435. Filed Sept. 30, 1891.

A brush movably fixed in a slideway to be pressed against the commutator and means of adjustment for maintaining uniform pressure.

Electric Mining Pick and Drill, J. Fish, 472,444. Filed April 29, 1891.
Musical Instrument, C. E. Guerre and G. H. Martin, 472,453. Filed Jan. 21, 1891.

Musical instrument consisting of a sonorous body vibrated by means of an electrical device.

Electromagnetic Valve Controller, O. E. Lundstedt, 472,461. Filed Aug. 6, 1890.

Railways and Appliances:—

Hanger for Electric Wires, H. H. Luscomb, 472,220. Filed July 20, 1891.

A trolley wire hanger having a head, a stem at one end of which the head is pivoted, and an arm serving as a stop for the head and also to transmit a part of the strain on the head when in use to adjacent parts of the stem.

Electric Wheel-Locking Device, G. W. Blanchard, 472,329. Filed Aug. 10, 1891.

Has for its object to lock an electric car thus preventing it from slipping back when ascending steep grades on the failure of the motor actuating current.

Inclosed Supply System for Electric Railways, J. C. Fyfe, 472,447. Filed Dec. 26, 1890.

Has for its principal object to provide means for supplying current to the motors of moving cars without exposing the conductors or contacts.

Switches and Cut-Outs:—

Switch and Switch-Box, S. Bergmann, 472,087. Filed March 18, 1891.

A switch intended for use in connection with a conduit.

Safety Cut-Out, M. Thum, 472,084. Filed June 5, 1891.

Consists of a safety device comprising a branch circuit connected with the guarded circuit and an electro-mechanical device in the former circuit adapted to change the guarded circuit upon a change of current in the latter.

Switch-Box for Electric Motors, P. Wright, 472,283. Filed Jan. 31, 1891.

An electric motor whose field magnets are in circuit with a source of energy and its armature on a derived circuit, in combination with a pole-changing switch and a second normally open independent circuit connected to the armature, whereby the first circuit may be broken and the second closed or vice versa.

Telegraphs:—

Unison Apparatus for Printing Telegraphs, H. Van Hoevenbergh, 472,237. Filed July 20, 1891.

Has for its object to provide means whereby the transmitting operator may be informed whenever the type wheel of the receiving machine is out of unison with the shaft of the transmitting instrument.

Telephones and Apparatus:—

Toll-Collecting Apparatus for Telephones, J. J. Kato and T. H. Rhodes, 472,169. Filed March 28, 1890.
Telephone Transmitter, E. G. Acheson, 472,243. Filed June 29, 1887.

A simple, cheap and effective transmitter, little liable to get out of order, self-adjusting and sensitive to very slight sounds.

A SEARCH LIGHT ON MT. WASHINGTON.[1]

BY LEWIS H. ROGERS.

Some time since I conceived the idea of establishing a search light on the summit of Mt. Washington, and after two months of active work on this matter alone, I have arrived at the conclusion that the idea is of vast interest and inestimable value, not to New Hampshire alone, but to the world.

In the manufacture of search lights the parabolic reflector has been abandoned by the Thomson-Houston Electric Company except for the smallest lights used on yachts. It was found that the parabolic reflector caused the beam of light to diverge so that the intensity was lessened and there was a haze between the beam of light proper and the surrounding darkness. This bothered ocean pilots to such an extent as to lead to the invention of the "silvered lens," made of the finest glass and ground by the most skilled workmen. The arc lamp proper (a pair of 2-in. hollow carbons) is placed at the focal point, 14 inches in front of the concave side of the glass. In front of this large arc lamp is placed a small reflector, which throws the light back 14 inches on to the concave surface of the glass lens, which is silvered on its convex side, making it a powerful mirror. From the concave surface the light is refracted through the glass on to this mirror which sends the ray of light out through the glass, past the arc lamp with its small reflector and out through the glass door which encases the front end of the whole arrangement. The rays of light therefore come out of the projector in a single straight and very powerful beam, which stands out in the darkness of the night as distinct as though it were something on which one could walk, reaching perhaps a hundred miles, and all along the way it can be seen touching a hilltop here and there and illuminating whatever may be in its path. As we begin to realize that in all probability this beam of light can be seen from a half dozen States, the Dominion of Canada and from far out at sea, we get some conception of the intertest which will be centered in this single spot. Those who see it from afar will want to see it closer. Those who read of it in distant States and who start East for a pleasure trip will surely see the great search light on Mt. Washington before they return.

And now, gentlemen, in answer to the question, What can New Hampshire do to attract summer tourists? let me reply briefly: Place a powerful search light on the summit of Mt. Washington and by its side a powerful telescope.

This light, in all probability, will be seen from the State House in Boston, and if so, a similar one can be placed in Boston and telegraphic communication established between the two points—so with Portland—so with Montreal. There is no telling how far the light can be seen as there never was such a light placed at such a height. This will be the highest and the strongest beam of light in the world. Let New Hampshire take her stand on this matter and she will be well repaid.

A PERMANENT STANDARD MAGNETIC FIELD.

A PAPER on a "Permanent Magnetic Field" was, reports our London correspondent, read at a recent meeting of the London Physical Society by Mr. W. Hibbert. The author said he had observed the approximate constancy of an aged bar-magnet, and he obtained still greater constancy by attaching pole-pieces to a bar-magnet of such a shape as to give a nearly closed circuit of small magnetic resistance. The pattern described consisted of a steel rod 1 inch in diam. and about 2½ inches long, with a cast-iron disc 4 inches in diameter and ⅝ inch thick fixed at one end; the other end was fitted in a hemispherical iron ring shell which surrounds the bar and comes flush with the upper surface of the disc. An annular air space less than $\frac{1}{16}$ inch wide is left between the cylindrical surface of the disc and the inside of the shell, and when the bar is magnetized a strong magnetic field exists in this space. To use this field for producing electromagnetic impulses, a coil of wire is wound in a shallow groove on a brass tube which can slide axially through the annular space, thus cutting all the lines. The tube is allowed to fall by its own weight, a neat trigger arrangement being provided for effecting its release. The instrument exhibited had 90 turns of wire in the coil, and the total magnetic flux across the air space was about 30,000 C. G. S. lines. A large electromagnetic impulse is therefore obtainable even through resistances as great as 10,000 ohms. Tests of three instruments show that there has been practically no magnetic decay in seven months. The author, therefore, considers them satisfactory, and is prepared to supply them as magnetic standards. To facilitate calculation the number of lines will be adjusted to a convenient number, say, 20,000 or 25,000. Several uses to which the instruments are well suited are mentioned in the paper, and a simple method of determining permeability by the magnetometer method is described.

ELECTRICAL DEVELOPMENT AT TROY AND PORT HENRY, N. Y.

THE work of applying electric power on the Troy City Railway is to be pushed at once, and in the course of the next two months the road will be in full operation to Albia. The erection of the power station will be hastened, and, if possible, completed before May 1. The contracts for machinery have been signed, and that branch of the work is already under way. The dynamos and engines will be ready to place in position as soon as the building is in condition to receive them. The Edison system will be used on this route, which has heavy grades. The Fifteenth street branch will be pushed to completion as soon as the legal proceedings now in progress are finished and the street formally opened and graded.

The Troy and Lansingburgh Railroad are busy with plans for the depot loop. The Mill street extension and Fourth street branch are only waiting for the street improvements to be made when the track force will at once begin with ties and rails.

The electric light station has placed a new 100 h. p. boiler, and the work on the additional plant will begin. Contracts have been let for building the new additions on the lot south of the present station, and as soon as the weather permits great progress in all the electrical lines will be made.

The village of Port Henry will have a complete electric street lighting system within the next three months. The National Electric Manufacturing Company of New York, of which Edward F. Murphy, of Troy, is president and Rensselaer County Treasurer Morey, treasurer, is engaged in organizing a local company to join with it in constructing and operating the plant. It is proposed to issue $25,000 in stock and $25,000 in bonds and expend the entire amount on the plant, which will be one of the best of its size in the entire country. The central station will be a brick building, and will contain a boiler of 125 h. p., an engine of 105 h. p. and dynamos of sufficient capacity to supply all demand. There are about eight miles of streets, and this will necessitate about thirty-two miles of street wiring, which will be upon poles of the most approved style. Over 1,700 lights have been engaged for stores and dwellings. This is outside of the number that will be necessary for the streets. It is proposed to buy in the Port Henry Gas Company, and thus give to the new company the benefit of the fullest possible demand from the start. The incandescent system will be used for streets and inside lights. The lamps will vary from 16 to 32 c. p., and the expense of the lights for house use, where meters are to be used, is equivalent to gas at $2 per thousand feet.

HOPE FOR THE WESTERN UNION.

THE Paris (Ky.) *Record* holds out to the Western Union Telegraph Company the following crumb of comfort:

"Frank P. Webb went to Lexington yesterday to take the position of bookkeeper for the Western Union Telegraph Company. This makes three Paris boys in that office, and were all taught by A. C. Adair, who says he can furnish the company a general manager if necessary."

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[1] Abstract of a paper read before the New Hampshire State Board of Trade, Concord, March 1, 1892.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Advertising is to business what exercise is to health.

THE GREENFIELD SWITCHES AND CUT-OUTS.

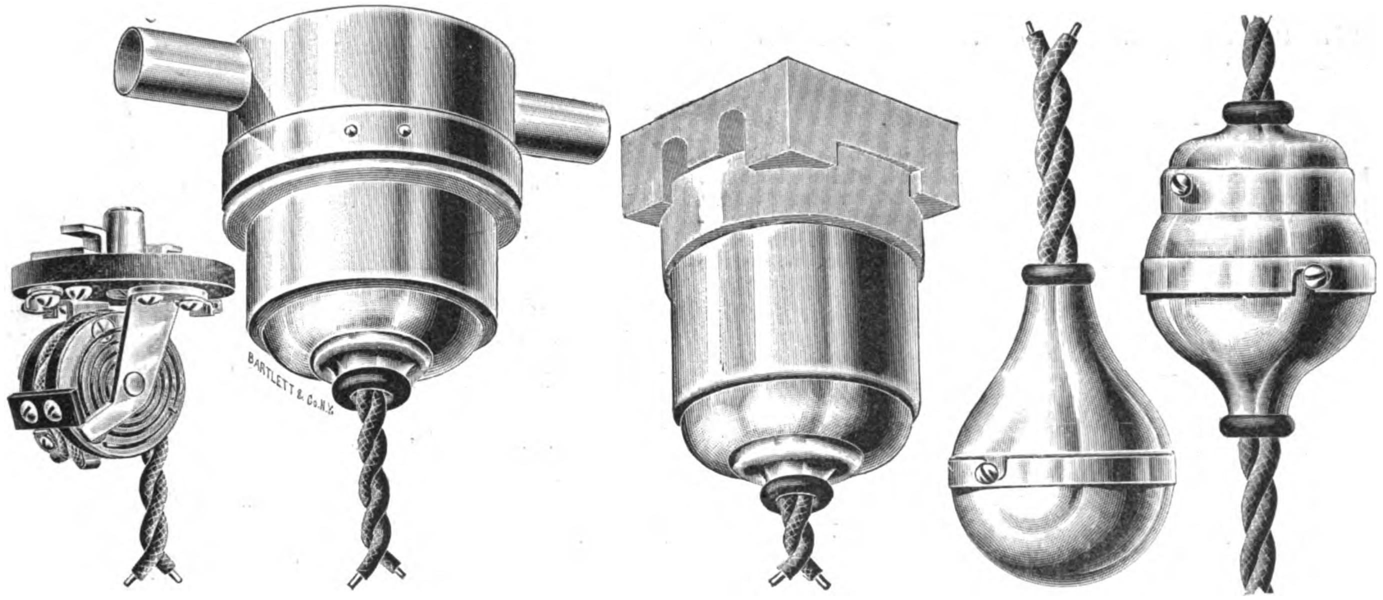
THE INTERIOR CONDUIT AND INSULATION COMPANY of this city have recently introduced a new combined pull switch and ceiling pendant cut-out, and also a new pendant pull switch, invented by Mr. E. T. Greenfield, the electrician of the company. These are made in a variety of forms, and are clearly shown in the accompanying illustrations.

Fig. 1 illustrates the interior mechanism which is employed in the different styles of switches and is concealed within the shells. This switch overcomes the difficulties experienced in turning on and off any style of key socket suspended from flexible pendants. Grasping either the cord or the lamp with the hand, the light may be turned on or off by a slight pull.

Fig. 2 shows the switch made to fit the standard conduit branch junction boxes and cut-outs manufactured also by the Interior Conduit and Insulation Company, and Fig. 3 represents the switch as adapted to the base of their "V. V." ceiling cut-out. The same mechanical principle employed in the combined pull switch and ceiling pendant cut-outs, is used to great advantage in the pendant pull switches.

Fig. 4 is a pendant pull switch designed for attachment to flexible cords for controlling incandescent lamps with the same freedom and safety as is experienced in handling an ordinary push button on an annunciator circuit. The switch may be used as a pendant from the centre of electroliers, thus dispensing with key sockets, and affording ready means for easily controlling the current. In general, it serves to bring within control lamps that are otherwise out of reach, permitting them to be turned on and off from any point that may be reached by a flexible cord.

Fig. 5 illustrates another application of the same mechanical principle embodied in the foregoing designs, and may be used with advantage in flexible cord pendants where it is not convenient to substitute the combined ceiling pull switch and cut-out for the ceiling block already in use. This switch may be inserted in any flexible cord pendant by simply cutting the cord and attaching the terminals to the binding screws provided for that purpose. As in the other forms of the same switch, the light may be turned on or off by a slight pull of the cord only. These switches are easily and quickly wired and are thoroughly reliable in every respect. In view of the fact that all the productions of the Interior Conduit and Insulation Company are noted for excellence of workmanship and finish, it is hardly necessary to state that the articles described above are compact in form and present a neat and attractive appearance. Once more this company have added a valuable article to their already long list of noteworthy specialties.


BARTLETT & Co. N.Y.

FIGS. 1, 2, 3, 4 AND 5.—GREENFIELD SWITCHES AND CUT-OUTS.

THE E. S. GREELEY & CO. FROM 1866 TO 1892.

NOTHING affords a more striking exhibit of the progress of electrical engineering during the past quarter of a century, than a comparison of the trade catalogues issued by prominent supply dealers then and now. In 1866 the firm of L. G. Tillotson & Co. then well-known manufacturers of railway supplies, decided to add a department of electrical goods to their business. The catalogue and price list issued at that time, now lies before us. It is a modest little pamphlet, 4 inches by 6, containing 20 pages, of which the last three are more than sufficient to accommodate the electrical department. As a contrast to this, the new catalogue of 1892, just sent out by the E. S. Greeley & Co., successors of the Tillotson house, is a thick book of no less than 450 pages, 5½ by 8½ inches, of which the index alone, closely printed in small type, occupies more than five times the space of the old catalogue. Only about thirty different articles are to be found on the original list, mostly telegraphic supplies, as in those days electricity was considered available for little else. The latest list embraces some thousands of different articles of every conceivable description, and more are being added every week, so that it is scarcely too much to say that a catalogue is out of date now-a-days almost before it can be got into print.

No less remarkable is the reduction in the prices of goods, which has been made possible by manufacture on a large scale, with improved and special machinery, and with studied reference to simplicity and effectiveness of design. In 1866 the price of the best Morse key was $7; a better one is now listed at $2. Relays were $22, not as good as now sold for $5. The sounder that cost $12 then, can be had for $3.50 now, and the reduction in other articles throughout the list is as great or greater than in the case of the apparatus mentioned.

At the time Tillotson & Co. embarked in this line of manufacture, there was only one other establishment of the kind in New York, and this one went out of business many years since. The old firm, and its successor, The E. S. Greeley & Co., have always maintained a leading position in the trade, and though they have made several removals, have always remained within a few doors of their original location at 26 Dey street. We venture to say that they will be found doing business at the old stand or in its immediate vicinity, 25 years hence, but how large a volume their catalogue will have expanded to by that time, is beyond the power of our imagination to undertake to prognosticate.

PEPPER & REGISTER.

THE above firm, of the Provident Building, Philadelphia, have secured the order to build and equip the Delaware Bay and Cape May Electric Railway, a six-and-one-half-mile road, with ten car equipments; generator to be 150 h. p., and cars to be equipped with 30 h. p. single-reduction motors, both of the Westinghouse Electric Company's manufacture. The Ball engine is to be used, Coatesville boiler and stack, Schieren's belts, Morris-Tasker Company's brackets for pole construction and Washburn & Moen's trolley wire. The road is to be in operation, complete, by the first day of June.

They have also secured the order to build, complete, the municipal electric lighting plant for Doylestown, Pa., and several isolated plants, work upon which will begin at once.

THE D. M. STEWARD MANUFACTURING CO.

MR. D. M. STEWARD, the head of the above concern, of Chattanooga, Tenn., has reached home after a trip through the country extending over two months and including more than 2,000 miles of railroad travel. In a business point of view, it was the most successful trip he has ever made. The material used in Lava insulators is of wide applicability, and is made up into a multiplicity of articles. As an indication of this, it may be mentioned that the actual sales of Steward's patent slate pencils foot up exactly 4,000,000 pieces; while many thousand gross of "Dustless School Crayons" and other specialties made by the company were also disposed of. Mr. Steward also effected extensive sales of Lava gas tips and burners for natural or manufactured gas. As to the Lava insulators, it is worthy of record that sales were made to old and new customers in every city visited, and in many cases standing orders were increased.

At the present time, the company is enjoying a steady flow of business from mail orders, and the increase in the working force goes on steadily so as to keep pace with the growth of the industry.

A LAMP FACTORY ON WHEELS.

SUCH is a Westerner's report as to a well-known New England firm. The truth of it is that the Germania Electric Co., in moving from its old place at Cambridgeport to the larger quarters at Marlboro, had to take to the steam horse, and probably shipped as fine a lot of testing instruments and pumps as was ever assembled on a train. The gain in facilities at the new factory which is just about ready for work, will allow the firm to turn out the improved Shaefer lamps all the more promptly, and we presume George Cutter will push all the more vigorously with this, one of his specialties.

THE RIEDEL ARC LAMP.

ONE of the most interesting of the recent improvements in arc lamps is that due to the ingenuity of Mr. Josef Riedel of Marlboro, Mass. In this lamp the arc is formed at a point of uniform height and regulated by means of movable carbon holders, which are operated by an electromagnet arranged on the top part of the lamp-supporting frame, and a suitable feed mechanism, while the formation of the arc is regulated by a second electromagent that produces the separation of the carbons when the current is switched into the lamp.

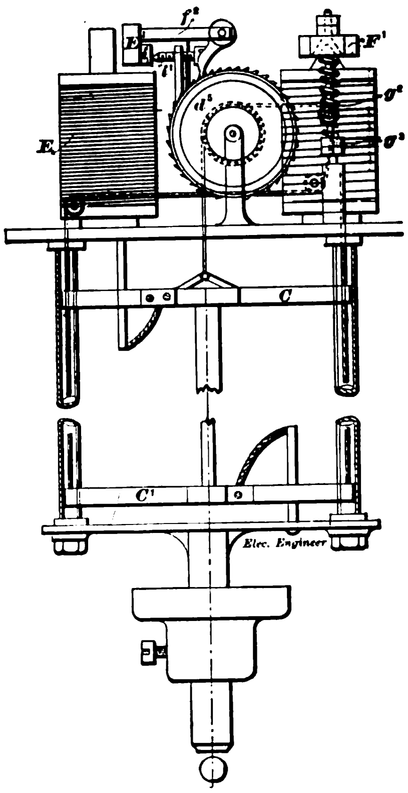


FIG. 1.—THE RIEDEL ARC LAMP.

The accompanying illustrations, Figs. 1 and 2, clearly show the method of operation, Fig. 1 being a vertical and Fig. 2 a horizontal view of the lamp. The cords d from the lower carbon holder C^1 run over the pulleys d^2 d^3 at the top of the frame, and also over a movable pulley d^4 on the armature of the magnet F. This magnet is in the main circuit, and hence, when the current is turned on, draws down the pulley d^4 and drops the lower carbon. The shunt magnet, E, actuating the ratchet wheel f, has attached to its armature a circuit breaker. The resistance of the arc, when it becomes too long, sends enough

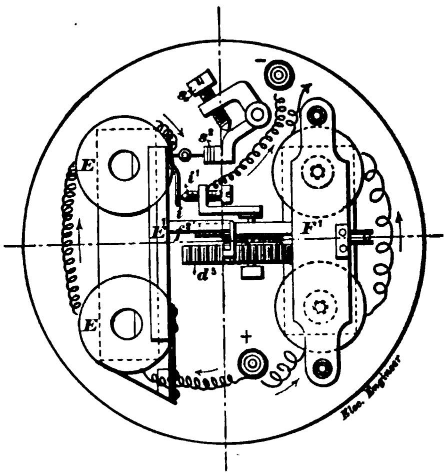


FIG. 2.—THE RIEDEL ARC LAMP.

current through the shunt to attract the armature of the magnet E and throws the circuit breaker into operation. The ratchet wheel f then slowly revolves and allows the carbons to approach each other.

Another advantage of this lamp is that its height is considerably less than most of those in use, thus effecting a saving in vertical space.

ELECTRIC HEATERS FOR STREET CARS.

AMONG those who have obtained good results this season with the Burton electric heaters is Mr. Enyart, of La Salle, Ill. His interesting letter is subjoined:

LA SALLE, ILL., Feb. 20, 1892.

ELECTRIC MERCHANDISE CO.,
W. R. MASON, Gen'l Mgr.,
Chicago.

Dear Sir: Replying to your favor about heaters, will say that during the winter 1890 and 1891 I experimented with a Burton heater, with the result that now every car on our system is heated with the "Burton Electric Heaters." I consider it the best method for heating street cars now in use, being clean, safe and cheap. I estimate that it costs us $1 per car per month for heat.

Yours truly,
(Signed) E. S. ENYART,
Supt.

A BIG WAGON FOR KERITE.

IT has remained for Supt. W. R. Brixey, of the Kerite works of Seymour, Conn., to produce the heaviest and largest vehicle of its class ever turned out. Recently returned from an extensive and interesting European tour, he brought back an idea of this rolling monster, from which has been evolved the heaviest draft wagon in America, with a freight capacity of 35 tons of kerite from the manufactory to freight depot, employing ten teams of horses. Mr. Brixey proposes to keep the wagon in steady employ hauling the output of the factory to the railroad, so that orders may be promptly filled.

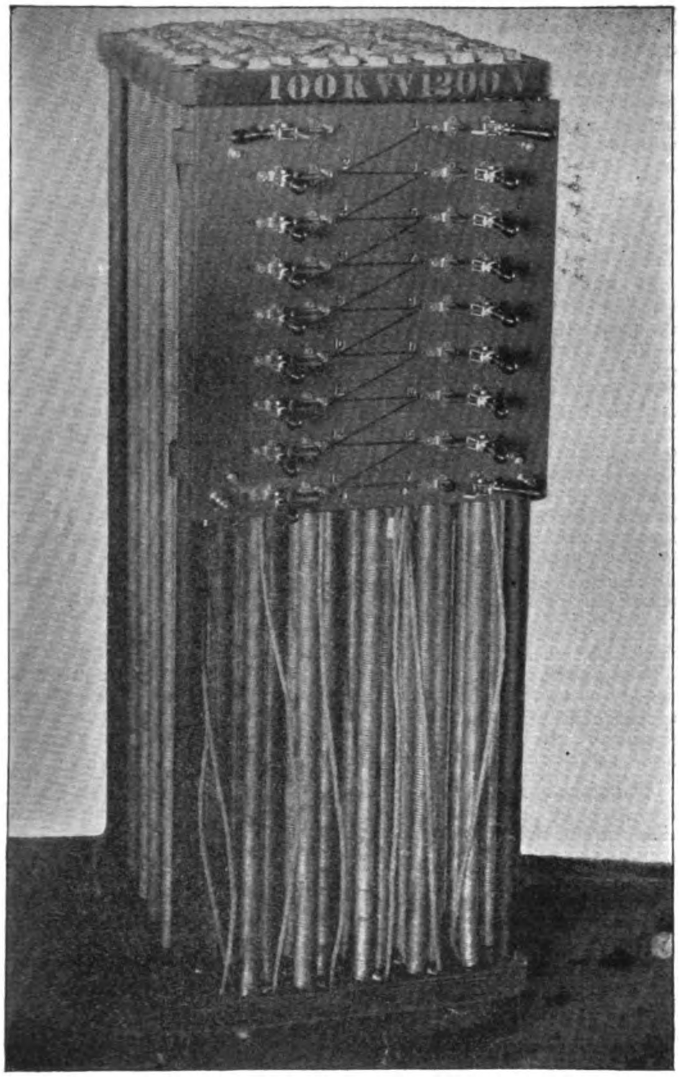
MORE WESTINGHOUSE ROADS IN NEW ENGLAND.

IN our last issue we noted the closing of important contracts at Fitchburg, Mass., and Waterville, Me., by Mr. R. S. Brown, the electric railway agent of the Westinghouse Electric Co. Mr. Brown, since then, has added some more roads to his list. He has just closed a contract for the equipment of the new palace car, which is to be put on the road of the Springfield, Mass., Street Railway Co. The car is a perfect beauty, built by Lewis & Fowler, with plate-glass windows, mahogany interior and the richest upholsterings. The Westinghouse motors, etc., will be of the best possible finish.

Another contract made by Mr. Brown is with the Worcester Consolidated Street Railway Co., for four car equipments, for that number of 34-foot cars. Each car will have two 25 h. p. motors. He is also to furnish two 20-foot cars with two 20 h. p. motors each, and one 250 h. p. generator.

THE EDISON CONTROLLING RHEOSTAT.

A NEW starting and controlling rheostat for motors running on high voltage currents has been recently designed by the Edison General Electric Company, and is clearly shown in the accompanying illustration. This is a modification of the standard Edison starting box for motors of large current capacity shown and described in THE ELECTRICAL ENGINEER of April 6, which is furnished with an ordinary switch base, fitted with a number of contact blocks and plates, arranged in a semi-circle around the pivot upon which turns the switch arm. The formation of arcs between the contact blocks, resulting in their deterioration and destruction, when the rheostats were used on high voltage circuits, constituted a difficulty which it became necessary to eliminate. The arcing could be avoided by employing a larger number of blocks on the board, but this would necessarily increase the cost of manufacture, as well as the size of the board.



NEW EDISON CONTROLLING RHEOSTAT.

The modification consists in the substitution of a switchboard with several separate and distinct switches, in place of the ordinary board just mentioned. By the employment of several separate switches it is possible to arrange the coils of the rheostat in multiple with themselves so that if it is required to carry a larger current, or remain in circuit constantly for the purpose of reducing the speed of the motor, it is comparatively simple to manipulate the switches according to requirements. The resistance is built up of tinned iron wire wound in spirals, and arranged in sections. Each of these sections can be thrown in or out by means of its proper switch. The rheostat is designed to start, and control the speed of, a 100 K. W. motor, working on a 1,200-volt circuit. The range of resistance is very wide, its greatest limit being 72 ohms, while, with the switches properly arranged it can be reduced to .25 of an ohm; the current-carrying capacity for the smaller resistance being increased in the same proportion. The over-all dimensions of the box shown, which was designed for an electric mining plant are: Height, 5 feet, 6 inches; width across switchboard, 28 inches; depth, 26 inches.

Rheostats of this design are absolutely fireproof, strong and substantial in construction, and have been arranged with a view to securing a high insulation resistance.

NEW ENGLAND NOTES.

THE FITCHBURG STEAM ENGINE CO. of Fitchburg, Mass., announce their removal into new quarters. For several years there has been an increasing demand for their engines until they were unable to keep up with their contracts, although running nights for some time. Their new factory is fitted throughout with all the best modern tools and facilities for handling large work, such as traveling cranes, etc., and is more than twice the size of their old plant. Their facilities for shipping are the best, as they can load directly from their erecting room on to the cars. They are now in shape to fill all orders promptly—for either large or small, vertical or horizontal, high speed, slow speed or compound condensing engines.

MR. C. A. BALDWIN, who has been for the past year the New England manager of the *Electrical World*, for the W. J. Johnston Company, of New York, has resigned his position with that company, to go into business with his brothers at 71 Devonshire street, Boston. They will hereafter conduct a business at that address under the title of Baldwin Brothers, and will make a specialty of handling electrical stocks, bonds and securities. Mr. Baldwin, during his year's connection with electrical newspaper enterprise, has made many friends for himself amongst the electrical trade, and enters his new duties with the good wishes of all who have come in contact with him.

THE HART AND HEGEMAN MANUFACTURING COMPANY, of Hartford, Conn., have recently been making large shipments of their well-known Hart snap switches to the West and South, and have had a great many calls for their large 75-ampere switch. This switch possesses many features of excellence. It is substantially built, and is small and compact for its capacity. A special feature of the Hart switch consists in the substantial binding posts provided, ample capacity being allowed for the reception of 000 wire, and overcoming the objection to many switches, whose binding posts are too light for the amount of current to be carried, and are not at all adapted for heavy currents.

THE CHAPMAN VALVE COMPANY, of Boston, whose factories are at Indian Orchard, Mass., have closed a contract with the Edison Electric Illuminating Company, of Boston, for the complete valve equipment of their new central station on Atlantic avenue. Their valve is specially constructed for use with high pressure steam, and is meeting with general approbation amongst electrical engineers. It will be remembered that the Chapman valve is used in the new power house of the West End Street Railway Company of Boston.

THE STANDARD ELECTRIC TIME CO., of New Haven, Conn., find a great interest aroused in their new electric tower clock, and they are having many inquiries regarding it from all sections of the country. They have recently contracted to place one of them in the new depot of the Chesapeake and Ohio Railroad at Newport News, Va. They have also closed a contract to place their system of electric clocks in the new Drexel Institute, Philadelphia.

NEW YORK NOTES.

HATZEL & BUEHLER, of 29 West Twenty-sixth street, report among recent contracts the following: To the New York Hospital, two 750-light generators of the Detroit Motor Works manufacture. This contract also includes two 75 h. p. Straight Line engines. To Austin, Nichols & Co., one 30 h. p. and one 15 h. p. Detroit motor. These, with several smaller contracts secured, have made a busy month for Hatzel & Buehler. To obtain space necessary for increasing business, this firm have secured very much larger quarters, and after May 1 will be found at 114 Fifth avenue.

THE H. W. JOHNS MFG. CO. of 87 Maiden Lane, has just issued some very neat price-list literature of its various asbestos productions for structural, mechanical and electrical purposes. It has also published a miniature color chart, which is one of the neatest advertising chromos we have ever seen. It tells what colors, tints, shades and color harmonies are, and shows the primary colors and the method of producing secondary colors from them. The company publishes also a large chart giving further information of the same kind.

THE SHORT RAILWAY SYSTEM.—The Short Electric Railway Company announce recent sales to the Braddock Electric Railway Co., Braddock, Pa.; the Union Passenger Railway Co., Chester, Pa.; the Fort Wayne Electric Railway Co., Fort Wayne, Ind.; the Schuylkill Electric Railway Co., Pottsville, Pa.

J. L. Somoff.—Rapid growth of business has compelled J. L. Somoff to institute a search for larger and more desirable quarters for the manufacture of his many novelties in incandescent lamps, surgical outfits, etc. A new catalogue is about ready for mailing, containing cuts of his decorative and other lamps and specialties. Mr. Somoff reports some excellent orders for his own peculiar style of goods from the Pacific Storage Co., of San Francisco, Cal., who are acting as his agents on the Pacific Coast. The Electric Appliance Co., of Chicago, will hereafter handle his goods also.

Ward Arc Lamps.—Noticing the many styles of lamps in the rooms of the Electric Construction and Supply Co., I was prompted to ask Manager Corey how many styles of lamps were manufactured by his company. When he answered 56, I confess I was not a little surprised. Mr. Corey further informed me that the making of these lamps for different voltages, etc., required over 500 combinations. They are having an extraordinary sale of their focusing and photo-engraving lamps, as shown at the Buffalo Convention.

Truex & Vail, electrical supplies, have taken a desirable "drop" in the Electrical Exchange Building, having removed from the sixth to the fourth floor, where they have secured a nice suite of rooms with a frontage on both Liberty and Washington streets. In their new quarters they have a good-sized laboratory and calibrating-room, in which the well-known Walker ammeters are calibrated. They report large orders for their swinging ball lightning arresters, Walker ammeters, etc., for which they are sole agents.

The New York Electrical Works have leased an entire floor at 161 Washington street, this city, and have placed therein a complete outfit of fine machinery. This company is now in a position to manufacture almost everything in the line of switches, etc., in fact, all the smaller apparatus required in electric installations. They are making a specially constructed trolley wheel made from a combination metal, which, they claim, will last at least twice as long as any wheel on the market.

Mr. A. S. Brown, manager of the Security Insulator Co., who has been ailing for a few days, is, we are glad to say, at business again. The Electric Appliance Co. of Chicago have been appointed Western agents for the Security insulator.

The Imperial Porcelain Works have opened a New York office at the Exchange Building, 136 Liberty street, Room 417. It will be in charge of Mr. C. E. Chapin, who will represent it as agent.

WESTERN NOTES.

Vincennes, Ind.—In 1886 the Vincennes Electric Light and Power Company installed their original steam plant, which consisted of two 9½ x 10 Armington & Sims engines; two 50 h. p. steam boilers, set with improved furnaces and grates; feed water heater; two Blake steam pumps, injector, etc. The company is now making arrangements to put in a 1,200-light alternating incandescent machine, for commercial and domestic service. Bids for enlarging and remodeling the power plant were invited, and a number of very elaborate plans and specifications were submitted. After long and careful consideration of the twenty proposals handed in, that of the Pond Engineering Company, St. Louis, was finally accepted, although the price asked was among the highest. It contemplates the furnishing of one 110 h. p. Armington & Sims engine and a 66 x 16 flange steel boiler, with rocking grates and Pond improved furnace; a 200 h. p. Hoppes feed-water heater, and two No. 4 Blake boiler feed pumps. The Pond Company is to deliver and erect all this machinery in Vincennes, at the same time remodeling the pipe work, so as to make a compact and well-arranged system throughout. It is expected that the new plant will be in operation early in May.

Mr. L. K. Comstock, electrical engineer, No. 427 Rookery Building, was recently called in to act for the Moline Central Street Railway Co., of Moline, Ill., in adjusting damages done by the recent fire in their plant in February, when they lost a railway generator and appurtenances. The plant was insured, and Mr. Foree Bain acted for the insurance company in the adjustment. The railway company immediately sent a representative to Chicago, where a 100 h. p. multipolar generator of the Westinghouse type was purchased. The road, during the interim, was supplied with current from the Davenport and Rock Island Railway Co., and not a single trip was lost on account of the fire.

The Woodward Storage Battery Car, which has been running regularly on the Jefferson avenue line, Detroit, is attracting a great deal of attention. With the batteries fully charged the car will run between eighty and eighty-five miles, while with the present facilities for charging, it only runs forty-two miles. Arrangements are being made to charge the car for eight hours each night, so as to render it capable of performing a full day's service. Meanwhile the car will run only during the afternoon. The Rae motor, which was lately put into this car, is giving entire satisfaction.

E. R. Gilman & Co., 140-141 Rialto Building, dealers in electrical securities, are offering at the present time first mortgage bonds of local companies at Faribault, Minn.; Neenah, Wis.; Escanaba, Mich.; Miles City, Mont.; and Colorado Springs, Col. They also have preferred income-bearing stocks for sale in the Chicago Insulated Wire Co.; the Great Western Electric Supply Co., and the Northwest Thomson-Houston Electric Co.

The Metropolitan Electrical Corporation has been formed at Kansas City, with offices at 415, 416 and 417 Whitney Building. Mr. T. F. Clohesy is the president. It intends to do a general electrical engineering business in the West, and will undertake contracts, construction, tests, etc., for all classes of light, power, storage and railway work. It will also serve as agent for a large line of light and power supplies.

Mr. John R. Markle, the well-known pioneer in electrical work of Detroit, Mich., is paying special attention to placing central stations, gas companies and similar corporations upon a sound commercial, financial basis and on a dividend-earning scale. Mr. Markle, from his long experience in fuel, gas, steam and electrical work is eminently fitted for giving reliable advice in such matters.

The Electric Appliance Company have just received their first shipment of Cutter specialties from Philadelphia and have them on exhibition at their store, where they are attracting considerable attention. The flexible bracket and portable as well as the C. S. shade are looked upon as very desirable specialties.

PHILADELPHIA NOTES.

Warren Webster & Co. report orders booked within the last few weeks as follows: Through their European Company, headquarters at Antwerp, Belgium, three orders for Webster's vacuum heater and purifier; U. S. A.—one 1,200 h. p. being second order from National Tube Works Company, McKeesport, Pa.; one 1,500 h. p. from Republic Iron Works, Pittsburgh, Pa.; one 1,500 h. p., third order from Annheuser-Busch Brewing Association, St. Louis, Mo.; one 1,600 h. p., fifth order from Cleveland Rolling Mill Company, Cleveland, Ohio; one 200 h. p. from Pennsylvania Steel Company, Harrisburg, Pa. Their factory is working to its full capacity, and the prospects of business are excellent for a very successful year. They also report that they have experienced an excellent business during the past winter with the Williames vacuum system of steam heating. They furnish catalogues free of expense, and visit plants at their own expense in any part of the United States where estimates are desired.

H. T. Paiste, the manufacturer and patentee of the Paiste switch and other specialties, has sold to the Bryant Electric Co. of Bridgeport, Conn., his patents on the Paiste single-pole switch, together with the business of the same. The transfer took place April 1. Mr. Paiste continues in the specialty line, and will introduce shortly to the electrical trade a number of new devices that he thinks will be appreciated by all.

Williamsport, Pa.—The Edison Electric Illuminating Company, whose plant is leased by Shaw & Hess, expect to make quite extensive improvements this spring, and will add another large dynamo with power to drive it. Mr. E. A. Rowley is president of the company.

R. Thomas & Son, of East Liverpool, Ohio, have purchased the entire porcelain plant formerly owned and operated by the Westinghouse Electric Company, at Pittsburgh.

The Pennsylvania Electric Engineering Company has the contract for wiring the new Hebrew Temple on Bond street for 500 lights.

The Imperial Electric Company are making a special run on porcelain insulators on which they are quoting rock bottom prices.

Mr. C. M. Wilkins, of the Partrick & Carter Co., has just returned from a pleasure trip to Florida with his family.

The Powelton Electric Light Company have added a Wood 60 arc light machine to their plant.

New Engines for Camden, Ark.—The Camden Electric Light and Power Co. write us that they have determined to buy a new 125 h. p. compound Ideal engine, and have made a contract for it.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

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A CHAPTER IN AMERICAN STORAGE BATTERY HISTORY—THE DONALDSON-MACRAE STORAGE BATTERY.

THE interest taken in the storage battery at the present day, and the strenuous efforts that are being made by electricians toward its perfection, render it difficult to realize that American work in this direction is only ten years old.

It was in November, 1882, that the steamship "Labrador" brought to this country some Faure-Planté cells, made of punched sheet lead, the holes being filled and the surface covered with a paste of red lead, and the whole being wrapped in flannel and bound with rubber straps. Experiments upon these in Baltimore resulted in the production of a cell similar to the present grid type.

A patent recently issued to Messrs. Wm. W. Donaldson and Roderick Macrae, of the Donaldson-Macrae Electric Co., of Baltimore, on an improved storage battery plate, recalls the fact that these gentlemen were the first, as far as we know, to engage in accumulator work in this country. Mr. Macrae was a student at the Glasgow Physical Laboratory in 1881, when Sir William Thomson received from M. Faure in Paris the famous "black box of stored energy," which created so much interest at the time and first directed attention to the possibilities of storage batteries. In 1883, he established, with the help of Mr. Donaldson, the first distributing storage station in the United States. This station was built in Baltimore for the Electric Storage Co., of that city, and had a plant of some 200 cells, supplying current for light and power in the vicinity. In 1884 a second plant was installed; this time in the cellar of the Academy of Music, for the operation of the stage lights. These stations, situated a mile apart, were both charged on the same circuit from the local lighting station, the accumulators, being placed in series. Both these plants, after over eighteen months' work, were discontinued, as the incandescent lamps at that time were very costly, and the repairs on the batteries were excessive. On one occasion $14 was realized on the sale of platinum wire taken from lamps broken within a period of three weeks!

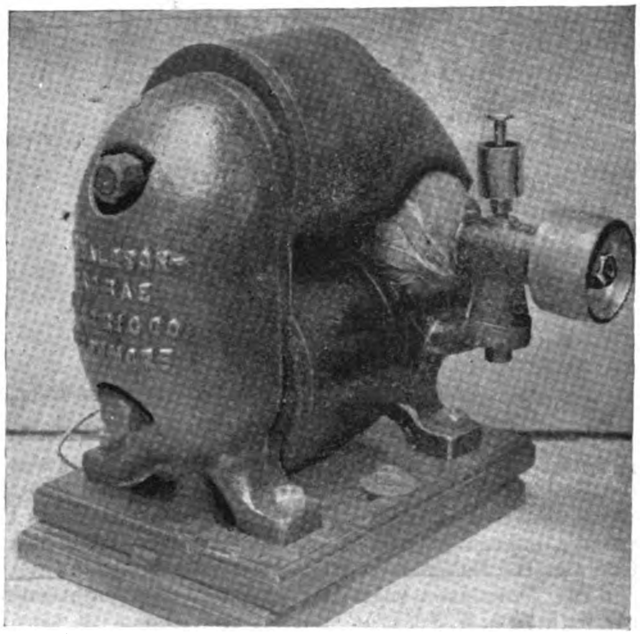

FIG. 1.—DONALDSON-MACRAE BIPOLAR DYNAMO.

Mr. Donaldson entered the field with Mr. Macrae in 1883, and in 1885 operated a car of the Daft line in Baltimore with 42 small cells. This led to other experiments in traction work, which continued for a year on an old car with a Van Depoele motor. In 1886 Mr. Donaldson took charge of the Crescent Club lighting plant, in Baltimore,

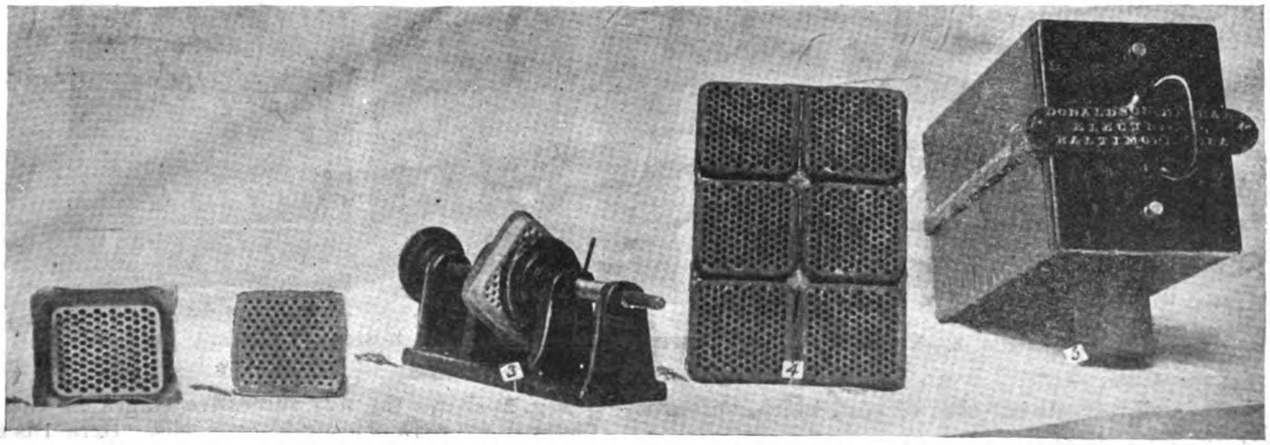

FIG. 2.—SUCCESSIVE STAGES IN THE MANUFACTURE OF DONALDSON-MACRAE STORAGE BATTERIES.

consisting of 350 one-h. p. hour cells and when, in the spring of the same year, the American Opera Company started on their Western tour, Mr. Donaldson took charge of all their electrical effects. Storage batteries were employed exclusively, 56 cells being charged about once a week in the large cities through which the company passed, and used on the "one-night stands" where current was not obtainable. After this time, during 1887 and 1888, Mr. Donaldson and Dr. Louis Duncan, of Johns Hopkins University, experimented with storage batteries for the Storage Company of Baltimore, with a view to their use in traction, and Mr. Donaldson successfully operated an eighteen-foot car with 7½ h. p. Sprague motors, climbing with ease the 7½ per cent. grades of the Baltimore streets. For eighteen months, these two gentlemen tried to get a successful thin plate accumulator and succeeded in producing one that was excellent in all respects but that of cost, which, unfortunately, was prohibitory.

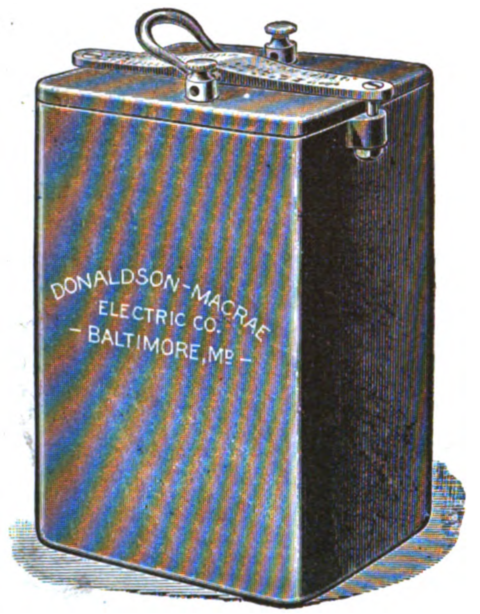

FIG. 4.—DONALDSON-MACRAE PORTABLE STORAGE CELL.

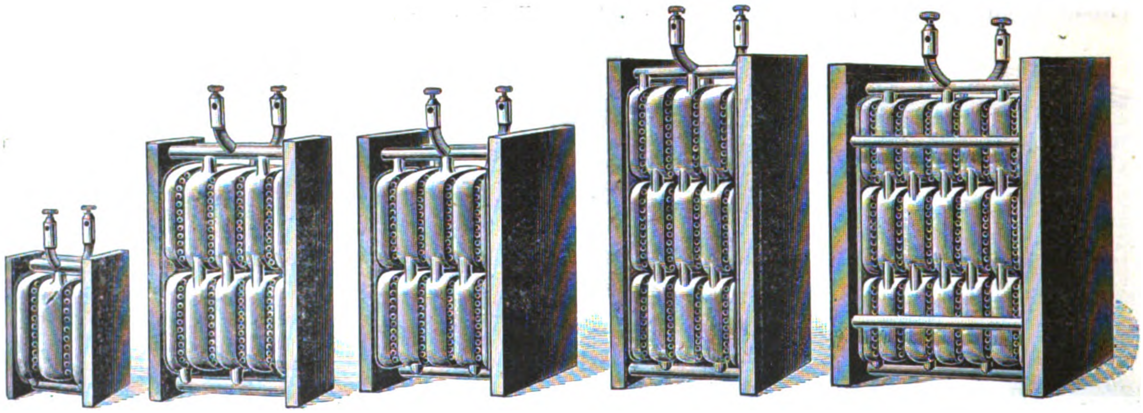

FIG. 3.—VARIOUS SIZES AND TYPES OF DONALDSON-MACRAE STORAGE CELLS.

In the latter part of 1889, Mr. Donaldson, who was then the agent for the Consolidated Electric Storage Co., started the first station for distributing storage batteries for phonographs, sewing machines, etc., the batteries being charged by the Donaldson-Macrae bipolar dynamo shown in Fig. 1 of the accompanying illustrations. This has grown until now there are over 500 cells of the Julien type in use in Baltimore and Washington, of which Mr. Donaldson has charge. Stations were afterward established in Cincinnati and Cleveland, and in January of this year the Storage Battery Supply Co., after consulting with Mr. Donaldson, started such a system in New York and Brooklyn.

Mr. Macrae has always kept abreast with the developments of storage work, and with Mr. Donaldson, incorporated in 1891 the Donaldson-Macrae Electric Co., of Baltimore. They have now perfected a battery plate which differs from all of the well-known types, being one inch in thickness and built up in sections. This type of cell has been in practical use since last August, one, according to the Columbia Phonograph Co., having run a phonograph for 100 consecutive hours. The elements of this cell weighed 33 pounds. These are now used in the Senate and House of Representatives, and also by Johns Hopkins and Washington and Lee Universities and the University of Nebraska, where Prof. Owens has 50 cells in use.

The cell is constructed by taking a standard section made by punching trays of sheet lead and filling them with active material, with holes extending from the surface up to the separation of sheet lead which is placed between two filled trays. The whole is then burned or welded together, and any number of sections are joined in one. The mode of support and clamping is most novel and a little rubber button is used to separate the plates.

The following table gives the special types of cells with their capacities and weights and the purposes for which they are especially adapted:

Type.	Cap'y. in Amp. hours.	Weight of Elements. Lbs.	Uses.
3 A	35	3	*Portable lighting.*
5 B	140	12	*Medical and telegraph.*
5 D	280	24	*Fan and sewing machine work and railroad lighting.*
5 F	420	36	*Phonograph and dental work.*
7 I	945	81	*Central station lighting and motor work.*

Fig. 2 shows the five successive stages in the manufacture of the Donaldson-Macrae cells. Here 1 is a piece of sheet lead punched and ready for filling; 2 shows a half section filled and trimmed; 3 is a view of two sections, showing the solid centre-piece in position ready for burning; 4 shows an electrode of type *E* consisting of four sections joined together, while 5 is an air-tight rubber case used for phonographic work.

Fig. 3 shows the relative sizes of the various plates, and Fig. 4 the type of portable rubber cell box adopted by the company, while Fig. 5 shows a diamond saw a rock specimen grinder operated by a motor driven by a single cell of this type.

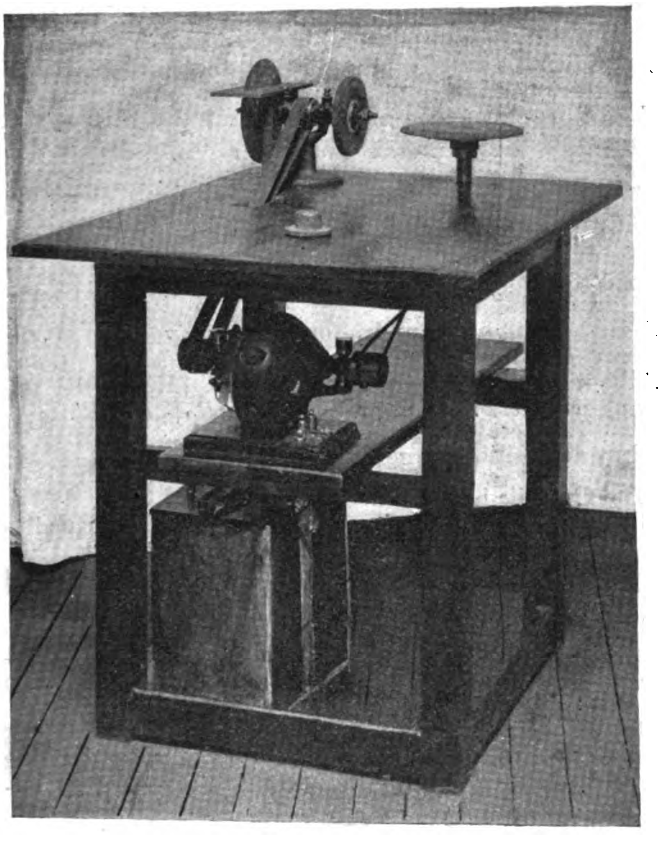

FIG. 5.—LABORATORY APPARATUS DRIVEN BY DONALDSON-MACRAE MOTOR AND STORAGE BATTERY

THE CONSUMPTION OF ZINC IN BATTERIES.

BY

F. W. Jones

IN THE ELECTRICAL ENGINEER of April 6, the answer given by Mr. Franklin L. Pope to my query in the previous number, "If 100 cells of battery in a circuit of 1,000 ohms separated as much zinc chemically as the same battery would do in a circuit of 2,000 ohms in which was included another battery of 100 cells," merely reaffirms the fact without carrying with it that elucidation so necessary to lower the conclusions of mathematicians to the plane of every-day workers in the telegraphic field. With the intention of making the subject a little clearer, I subjoin some tabulated calculations in which the cells are assumed to be one volt each, and the electro-chemical equivalent of zinc as 0.0003367 gramme, which is the weight deposited by one coulomb, that is, an ampere for one second.

By this table it will be seen that the quantity of current (amperes) in each case is in direct proportion to the number of cells in circuit. The energy (watts) is in proportion to the square of the number of cells, as is also the consumption or chemical separation of the zinc. By inspecting the table it will be seen that if one cell is working alone in a circuit of 1,000 ohms it will expend double the energy and produce twice the current and consume twice the quantity of zinc that a similar cell would do in a circuit of 2,000 ohms. In a circuit of 1,000 ohms, 100 cells will give *one hundred times* stronger current than is given by one cell *alone* in the circuit, expending 10,000 times more energy and consuming 10,000 times more zinc. Each cell working in the series of 100 will consume *one hundred times* more zinc than if it were unassisted by the other 99 cells. Yet its individual current as determined by $C = \frac{E}{R}$ is the same in either case.

The table also shows that 100 cells consume as much zinc *per cell* in a circuit of 1,000 ohms, as 200 cells consume *per cell* in a circuit of double the resistance, and that in a circuit of 2,000 ohms, 200 cells will consume 40,000 times as much zinc as one cell working alone and furnish only 200 times the quantity of current; but as the 200 cells carry into the circuit 200 times more electromotive force, as well as current $\left(C = \frac{E}{R}\right)$ therefore the product of the volts by the amperes becomes a measure both of the energy and of the necessary consumption of zinc to produce it.

Cells.	Ohms in Circuit.	Ampere.	Watts.	Zinc Consumed per Second.		
				Total Grammes.	Total Grains.	Per Cell. Grains.
1	2,000	.0005	.0005	.00000016835	.000002598	.000002598
10	"	.005	.05	.000016835	.0002598	.00002598
100	"	.05	5.	.0016835	.02598	.0002598
200	"	.1	20.	.006734	.10391	.0005196
1	1,000	.001	.001	.0000003367	.000005196	.000005196
100	"	.1	10.	.003367	.05196	.0005196

A POINT OR TWO ON PRIMARY BATTERIES.

BY

Walter A. Crowdus

IN a recent article in THE ELECTRICAL ENGINEER upon the much-abused primary battery, I was pleased to see Mr. A. E. Kennelly touch upon the true basis of economy in the chemical generation of electricity, namely, *internal resistance.* The output from any cell, whether in volts, amperes or watts, as well as—if I may term it such—the "currency efficiency," are all dependent upon this one factor. In keeping with other queer things, peculiar only to the primary battery, the smaller this factor R becomes, the greater benefactor it becomes.

Not wishing to shield behind the modern maxim that nothing is impossible, or to aim a blow at superior intellects because of early incredulity, it is nevertheless a lamentable fact that the slow progress towards the commercial development of the primary battery is directly due to the subject having been taken up by electricians instead of chemists, and having been chiefly studied from an electrical standpoint, without regard to, and in many cases without an elementary knowledge of, its chemical reactions—primary to the secondary effect of volts and amperes. Is it then becoming to the electrician to condemn Nature's most powerful and wonderful secret chamber because he does not find upon its threshold the object of his search?

The primary battery thus becomes a chemical problem; but allied with it and of no less importance is a thorough knowledge of electro-chemistry; but ere we have progressed far, a third important factor, which may be said to be wholly mechanical, appears. Then we have in the most perfect battery, three subjects which must be met and disposed of to obtain true results, and our problem becomes one of no mean proportions and deserving more attention than has been allotted to it in modern times. I shall endeavor to partially illustrate how these three distinct factors influence in one way the efficiency of a two fluid cell by their direct relation to its internal resistance. The electrical books treating of primary batteries give us no light upon these points and beyond the common idea of increasing plates to increase current, nothing has been embodied in the commercial cells.

Every battery has three internal resistances, *i. e.*, three separate factors, which go to make up the internal resistance proper. I mean the chemical, mechanical and electrical resistances.

The chemical resistance is that resistance opposing the osmotic action or affinity of the separated solutions, and is represented by the pores, or holes in the separating diaphragm. A high chemical resistance has always been considered to entail a high electrical resistance; this I have discovered is not necessarily so.

The mechanical resistance is the solid particles of the separating diaphragm. A high mechanical resistance necessarily gives a high chemical resistance, and has in all existing batteries effected a high electrical resistance. This last, I have proved, is not necessary.

The electrical resistance is the combined resistance of the excitant and depolarizer interposed between the positive and negative elements; hence the larger the elements, the lower the resistance of the liquid; or the closer the elements, the lower will be the liquid resistance. (A small electrical resistance may exist in the elements themselves.)

As a deduction from the above, the most perfect battery would be one having the highest possible mechanical and chemical resistance and the lowest possible electrical resistance; the results would be, no local action, no waste on open circuit and a very small R, while the output of any existing cell would be increased fivefold, with a like increase in its "currency efficiency." In short, internal resistance in a battery is the same as friction in moving machinery, and though the statement may seem incredible to some, it is true that of two cells performing equal work in any external circuit, and having, respectively, an internal resistance of one and four ohms, the latter will dissolve four times as much from its positive electrode as the former, will require four times the quantity of excitant to oxidize it and demand four times the quantity of oxygen to take care of the liberated hydrogen. The one is spending its force exterior to itself; the other is consuming three-fourths of its energy before reaching the external circuit. I might add that a certain open circuit battery upon the market owes its merited success largely to its low internal resistance. Hence, the efficiency of a battery is expressed by dividing the resistance of the external circuit R' by the sum of the internal R and external resistance, *i. e.*, efficiency $= \frac{R'}{R + R'}$.

This should also disprove the popular idea that the resistance of the external circuit should be the same as the internal. A trial will show the battery would then be working at an efficiency of only 50 per cent. by the above rule, and, introducing heat loss, it becomes even less. Such practice is not followed in any other applied science. This R, generally regarded of no moment, is the most expensive luxury when we pay for the chemicals it consumes. Accompanying the neglects I have cited, I have found that users of primary batteries have been wholly without laws, rules, or formulæ by which they could intelligently gauge the size or number of cells suited to a given circuit; and fairly good batteries have brought sorrow to the purchaser and discouragement to the poor inventor because of faults exterior to the cell. Like the mule, the primary battery has been abused on general principles. With a hope that I may benefit some, I give below some simple equations based on Ohm's law, which can be used to eliminate all errors and guessing, and, if correctly applied, cannot fail to bring about good results.

The difference between the gross E. M. F. of a battery and the difference of potential it can maintain in any exterior circuit is strictly proportional to the resistance of the several portions.

Let E represent the gross E. M F. of the battery; C, current through its own resistance; R, its internal resistance. By Ohm's law $C = \frac{E}{R}$, and $R = \frac{E}{C}$. This same law applies to the external circuit. Hence we get the second equation, $C' = \frac{E'}{R'}$; whence, $R' = \frac{E'}{C'}$; in which E' is the fall of potential, or available voltage in the external circuit; C', the current in the external circuit, and R' the resistance of the external circuit. Hence the following proposition holds good, $E : E' :: R + R' : R'$.

By transposition we get $E' = \frac{E \times R'}{R + R}$.

The first rule is written thus:

RULE 1: The available voltage of a battery is equal to the product of its electromotive force and external resistance divided by the sum of the external and internal resistances.

In the above equation it is necessary to know the resistance of the external circuit. If this is not known the current in the external circuit can be taken and the equation written: $E' = (R \times C') - E$.

To find the value of R' we have:

RULE 2: The external resistance is obtained by dividing the electromotive force by the current in the external circuit and subtracting the internal resistance: $R' = \frac{E}{C'} - R$.

To find the value of C' we write:

RULE 3: The current in the external circuit is equal to the electromotive force divided by the sum of the external and internal resistances: $C' = \frac{E}{R + R}$.

Thus, knowing any two factors of a given cell we can calculate the values of any number of cells for any circuit without the use of voltmeter or ammeter.

PHOTOGRAPHING BULLETS.

In a lecture on this subject, delivered recently at the South Kensington Museum, Prof. C. V. Boys explained his apparatus for the purpose. It consists of a box lined with black cloth, in which the photographic plate is exposed; of a condenser formed of a plate of glass about a foot square; of a smaller condenser in the form of a bottle, to act as a starter of the spark; and of a system of wire circuits and knobs to give the spark which throws the shadow of the bullet on the plate, and thus takes the photograph. The bullet enters and leaves the box by two holes, covered with paper to exclude the light; and in passing the plate the bullet touches the terminals of two wires, composed of thin lead wire, thus partly completing the circuit; a small flash passes from the smaller condenser, causing a larger flash to pass between the knobs of the plate condenser inside the box; and this flash lasting less than one-millionth of a second, takes the photograph of the bullet, no lens being employed. A wet string in the circuit of the small condenser is used to damp the electrical oscillations. Mr. Boys was able to infer from his experiments with a rifle that the bullet must have received some three per cent. of its velocity after leaving the muzzle, at which point the turning effort of the rifle must have necessarily ceased.

"KOBOLDS" IN ELECTRO-DYNAMICS.

BY

Fred A. Schaffler

THE mechanical or electrical experts who read this article will become aware that the writer's purpose is not to advance whys and wherefores with a view to promulgate a new term for applied electro-dynamics, although the word should be applied to the *investigation* of such science, and it behooves me to show cause for such a statement. To those who are uninitiated I will explain that a "kobold" is any mysterious occurrence which takes place when you least expect it. For better comprehension one example will suffice. When you are in a desperate hurry to finish dressing, you lose your collar button, and as this invariably happens at exactly the wrong time, and you hunt, not high, but low for it, under the bed, dresser, in your slipper, and every place but the right one, you are much vexed thereat. That's a "kobold;" and they permeate everything, and anything, but seem to be more prevalent in electrical investigations, experiments, etc., than in any other branch of science or manufacturing business, according to one person's experience at least.

There are two kinds of kobolds; good ones and bad ones; but more particularly do they assume characters which are extremely bad. Occasionally you will meet a little fellow cropping out through some experiment which leads you to become effusive over the recent discovery. Further and prolonged investigation only tends towards showing you how egotistical you are, and how with much nursing the promising kobold develops into a veritable demon of improper proportions and of disappearing qualities and quantities. There is only one family of kobolds in electro-dynamics, but they are known by many names, such as short-circuits, open circuits, grounds, "niggers," improper armature and field windings, disproportion of armature core to field, swinging ground, sparking and flashing at commutator, loose connections, etc.

Sometimes the more promising young kobold proves himself to be of first-class character, and your investigation, invention, theory, or whatever it may be that you are at work upon really develops into a result which is most practical and useful.

It is more than certain that the most obnoxious and expensive kobolds (there is always more or less expense attached to the "funeral" of any kobold) have and do make their appearance in storage batteries. Sometimes in this part of electrical affairs two years elapse before they become fully developed, but from the time the battery or cell is finally constructed they are there in embryo.

Armatures, converters and street car motors seem to be more particularly afflicted with abominable kobolds, when in daily use, than, perhaps, any other apparatus of applied electro-dynamics. In street car motors the unsophisticated driver, or "motorneer," as he is sometimes called, can in twenty seconds by a simple twist of the wrist produce the most frightful kind of a kobold. I do not mean to say that the development occurs before the driver returns to the car shed, but rather afterwards, when he explains how he is not responsible, and that everything happened when the car was running so nicely, etc.

It is exceedingly strange that some, if not all, of our most prominent electricians can and have produced very discreditable kobolds, and the cost of rectifying the same would, if properly accounted for, furnish a first-class endowment for a university where the practical application of the science of how not to do it could be taught to great advantage. We would all very much enjoy reading an account of the experience with kobolds of some of our prominent electricians—men who have had much acquaintance in matters of both theoretical and practical nature. Such a recital would do us all good, and would surely give us something wherewith to whet our solicitude for all matters of an electrical nature, and create within us a new desire to live down any disconsolate feelings we may have, for we would then have in black and white statements which show that others who have more knowledge of the science have also been blessed with obstinate and surprising kobolds.

Prof. Sweet, of Syracuse, some time ago presented a paper to the American Society of Mechanical Engineers, entitled, "The Unexpected which Always Happens," and it was the writer's original intention to give this article the same title, but also to add "No. 2." The word "kobold" is much shorter, and when you grasp its actual meaning is fully as comprehensive as the more lengthy expression above mentioned.[1]

Sometimes these kobolds will persistently follow all attempts to attain certain ends, and this usually occurs when the ends sought after are required for immediate use, or not at all. I will instance a series of delays and misfortunes which occurred to a prominent electric company last fall when preparations were being made with a view of presenting a fine exhibition at the Convention of the Street Railway Association at Pittsburgh, and in which the prince of kobolds himself gave personal attention to the preparations, with a very evident intention of preventing such an exhibition being given, at any cost. Arrangements for this representation were begun fully six weeks previous to the opening day, and this time would have been ample under ordinary circumstances. The principal apparatus to be exhibited consisted of three machines, a new waterproof single-reduction motor, the great and only gearless motor (which for the first time was to be shown in all its glory to street railway magnates promiscuously, and placed in daily operation for open-handed and fearless investigation) and a new, latest improved 200 h. p. generator. The first of these was an entirely new type of motor, and the entire machine had to be built from beginning (patterns, etc.,) to end, in the time allotted, six weeks. Work progressed finely until one week before the convention was to be opened. Then the first kobold made his appearance. He was only a little fellow compared with his relatives whose acquaintances were made that week, in which there were only the usual six working days, *and nights.* The motor was at last finished, except the testing, and every one interested felt lighter hearted. Current was delivered to the motor and the test began. Didn't the machine run beautifully? Weren't all competitors to take a back seat when the prize "S. R. G." was exhibited? Fizz ! !! !!! !!!! The armature still revolves, but the commutator will soon be "burnt up" if the current is not open-circuited. An examination shows that owing to the haste made by an armature winder, a defect in insulation had caused several bobbins to be short-circuited, and a burn-out occurred. It will require one day and one night to kill that kobold and complete the armature for test again. This test was made, and only four days remained before the exhibition was to be opened. Two more changes were required, then the motor would be completed at last. Nothing further occurred to interfere and the motor was sent on its way to play a prominent part in the railway exhibition.

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[1] An article, which the writer came across entitled "Kobolds; there are such things," from the *London Globe* in *Current Literature*, was the first intimation I had of their existence, but the subject was especially applied to their relation to humanity. The specific origin is, of course, the little imp in Norse literature, corresponding, I presume, to the "Brownie" in ours

In the meantime work was progressing on the gearless motors and generator. To cut a long story short, after many more interferences from outside and unseen enemies, the gearless motors were completed. Each kobold delayed making its appearance during the six weeks until three or four days preceding the latest possible time for shipment of the apparatus. The generator proved to be proof against any kobold attacks of an electrical nature, but the prince above referred to made his presence known just at the time of shipment. The party who had the contract for loading the generator had previously handled eight machines of the same size without any accident whatever. Why should anything happen to this particular one, especially when there lacked only three days before convention time? The only explanation is that kobolds sometimes get into a man's head, where they can do as much damage as they can in a more in animate object. Suffice it to say that the "boss" had concealed in his pocket a bottle of Jersey lightning, and although he was perfectly sober when he came to the works to haul and load the generator, he in due time became, by long and frequent draughts of the liquor, so intoxicated that his assistants played give and take with him in language more expressive and emphatic than gentlemanly. By this time the generator was ready to be hauled off the rear of the truck on to the end of the car, and the switch engine was waiting to pull the car out. Through careless placing of the rollers under the generator, as soon as the tackle was made taut, the big box, containing 20,000 pounds, fell off the truck and came to rest in a good many pieces, with the generator upside down on the sidewalk; and it was half past six at night! The machine fell in such a position that it was impossible to pull out the car containing the exhibition motors and truck, as one corner of it obstructed the track. The services of the drunken teamster and his outfit of assistants were immediately abandoned, and by using "jacks" and the help of many hands the generator was moved sufficiently to permit the car to be pulled out. All that night a force of men were at work placing the machine right side up and returning it to the shop for repairs. Here, upon investigation, another surprise occurred. Every one interested fully expected to find that expensive injuries had been sustained, considering the fact that the generator had fallen five feet, but beyond bending a few trimmings and jamming of magnet heads and smashing the packing box, nothing was damaged! The machine was again packed and shipped the evening following the accident, and arrived at the exhibition in time to demonstrate that certain kinds of dynamos can be almost as roughly handled as a portable boiler in the oil regions.

The imp of a kobold followed that generator to Pittsburgh, however, where it fell off the truck twice while being conveyed from the freight depot to the never-to-be-forgotten exhibition barge, and many eyes watched it with misgiving, fully expecting that the final roundup of adventures would be the dumping of the generator into the Monongahela River.

These kobolds, after all, have their mission, and serve only to make us become more watchful and to more carefully consider the pros and cons of our design or work, or whatsoever we may be engaged in. Experience is a faithful teacher, but we do not like to get it so frequently in the shape of a *cave canem* manner.

In a recent report to the Counseil Municipal of Paris, M. Paul Brosse gives some statistics with regard to the relative positions of gas and electricity in that city. The consumption of gas continues to grow, although the rate of increase is somewhat less than it was. The Paris central stations have at the present moment a plant capable of developing 17,500 h. p.; when complete this figure will become 32,000. During 1891 the gas consumed in Paris amounted to 10⅓ million thousand cubic feet. Out of 85,000 houses only 20,000 are fitted with gas.

ON THE MEASUREMENT OF THE POWER GIVEN BY ANY CURRENT TO ANY CIRCUIT.

BY

Norman Whichello.

Most electricians have, no doubt, seen an account of Prof. Ayrton's 3-voltmeter and 3-ammeter method of measuring the power given by *any* current to *any* circuit. To those familiar with calculations dealing with alternating currents, such a method would at first sight seem an impossibility in the case of an alternating current which is not a sine wave but some unknown function of the time, and still more so in the case of a more complex current such as an intermitting current. Although I have frequently seen the results stated, I have never been able to get hold of a proof, and have accordingly investigated it myself, and find that the proof is very simple when once on the right track. As many of the readers of The Electrical Engineer may be similarly situated, I think the proofs given below may be of interest.

The whole principle of the proof depends on one leading fact. We are all familiar with the fact that the product of the mean values of two variables, is not the same as the mean value of their products. If it were, we should simply have to multiply ammeter and voltmeter readings together to get the watts given by an alternating current to an inductive circuit. It *is* true, however, that the sum of the mean values of two variables is equal to the mean value of their sums.

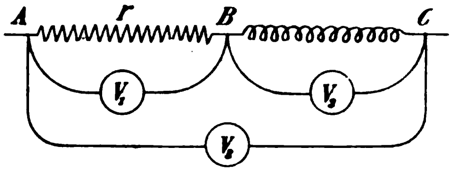


Fig. 1.

An example may make this clearer. Let x and y be two variables, and let them assume the values given below. The values of x are 1, 5, 6, and the simultaneous values of y, are 2, 3, 1.

The mean value of x is evidently 4 $\left[i.\ e., \frac{1+5+6}{3} = 4\right]$

and the mean value of y is evidently 2 $\left[i.\ e, \frac{2+3+1}{3} = 2\right]$

∴ the sum of the mean values of x and y is 6 [*i. e.*, $4 + 2 = 6$]. Now the separate sums of x and y are 3, 8, 7 [*i. e.*, $1 + 2 = 3$, $5 + 3 = 8$, $6 + 1 = 7$]. And the mean of these is 6 $\left[i.\ e., \frac{3 + 8 + 7}{3} = 6\right]$. Therefore the sum of the mean values of two variables *is* equal to the mean value of the separate sums - - - - - - - - - (1)

And the reader can easily see by trial that the same is true of the difference, *i. e.*, the difference of the mean values of two variables is equal to the mean value of their differences - - - - - - - - - - - (2)

The results (1) and (2) follow immediately from the fact that $(x + y)\ dt = x\ dt + y\ dt$. Now consider the products. The mean values are as before 4 and 2 and their product is 8. Their separate products are 2, 15, 6 [*i. e.*, $1 \times 2 = 2$; $5 \times 3 = 15$; $6 \times 1 = 6$], and the mean of these is $7\frac{2}{3}$ $\left[i.\ e., \frac{2 + 15 + 6}{3} = 7\frac{2}{3}\right]$.

Hence the product of the mean values of two variables is *not* equal to the mean value of their products - (3)

The same is true if we read ratio for product - - (4)
The results (3) and (4) follow from the fact that $(x\,y)\,dt$ is not equal to $x\,dt \times y\,dt$.

We can now deduce the expression for the power. The circuits are joined up as indicated in Fig. 1. Here B C is the circuit, the power given to which we wish to measure. A B is a truly non-inductive resistance of r ohms $V_1\ V_2\ V_3$ are the readings of three Cardew or other suitable voltmeters. $V'\ V''\ V'''$ are the corresponding instantaneous values of the P. D's. Now $V' + V'' = V'''$, although of course $V_1 + V_2$ is not equal to V_3. Also V_1^2, V_2^2, V_3^2 are the mean values of $V'^2\ V''^2\ V'''^2$ respectively, assuming, of course that the alternations are rapid enough to prevent the needles from oscillating with the P. D. And this will be true however complex the wave of P. D. may be.

The power being supplied at any moment to B C is $C\,V''$, C being the instantaneous value of the current. This is the product of two variables, and (4) tells us that its mean value is not $V_2 \times$ the effective current. If, however, we can throw this expression into the form of sums or differences, or both, instead of a product, then we can use (1) and (2) at once. This, fortunately, is easy.

$$C = \frac{V'}{r} \text{ since A B is non-inductive.}$$

$$\text{Therefore } C\,V'' = \frac{2\,V'}{2\,r}\,V''$$

$$= \frac{1}{2\,r}\left[V'''^2 - (V'' + V')^2 + 2\,V'\,V''\right].$$

$$\text{since } V''' = V'' + V'$$

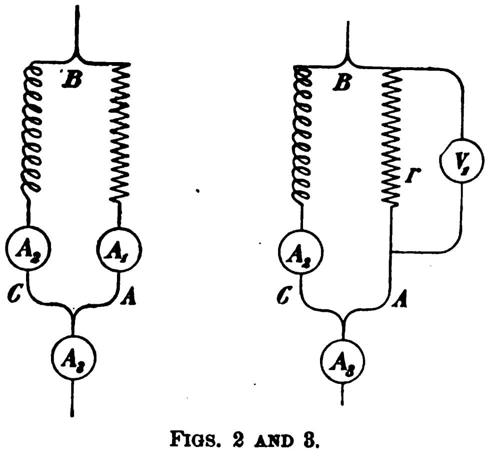
$$\text{reducing} \qquad C\,V'' = \frac{1}{2\,r}\left[V'''^2 - (V''^2 + V'^2)\right]$$

and this *is* in the derived form of sums and differences. Therefore the mean value of the power given to B C is $\frac{1}{2\,r}\left[V_3^2 - (V_2^2 + V_1^2)\right]$ which is the expression given by Prof. Ayrton.

The three ammeter method may be proved in exactly the same way. In Fig. 2, B C is the circuit the power given to which we wish to measure. A B is the non-inductive resistance of r ohms. $A_1\ A_2\ A_3$ are the three ammeter readings.

It is very easy to see that the mean value of the power given to B C is $\frac{r}{2}\left[A_3^2 - (A_2^2 + A_1^2)\right]$.

If it be objected that A B cannot be truly non-inductive because the ammeter A_1 must necessarily have self-induction, we may replace A_1 by a voltmeter, as shown in Fig. 3. $\frac{V_1}{r}$ of course takes the place of A_1 in the formula.



FIGS. 2 AND 3.

The second method is superior to the first in that it does does not require the dynamo to give a higher P. D. than the P. D. on B C which makes the method convenient for testing the efficiency of a converter in situ, B C being the primary side of the converter; it is inferior to the first in that it requires three instruments, whereas in the first case a simple arrangement of keys or mercury cups enables one voltmeter to give all three readings.

While on the subject of measurement of the power it might be well to speak of the electrometer method, as this also can be shown by the aid of (1) and (2) to measure the power given by *any* current to *any* circuit.

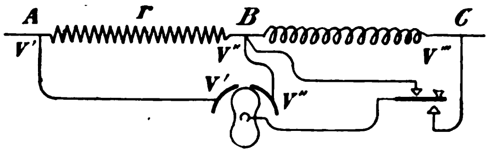


FIG. 4.

The circuit is joined up as shown in Fig. 4, r being the non-inductive resistance in series with the circuit the power given to which we wish to measure. The pairs of quadrants [one member only of each pair is shown in the sketch] are connected as indicated. The needle can be connected to either end of the inductive resistance by a key. $V'\ V''\ V'''$ are the instantaneous potentials of the points indicated. $D_1\ D_2$ are the deflections of the electrometer when the key is depressed and raised respectively. $D'\ D''$ are the instantaneous deflections which we should have if the electrometer were dead beat enough to follow the alternations.

The law of the electrometer is

$$D = k\,(V' - V'')\left(V - \frac{V' + V''}{2}\right)$$

where V is the potential of the needle and k the constant of the instrument. If we depress the key, $V = V'''$

$$\text{and } D' = k\,(V' - V'')\left(V''' - \frac{V' + V''}{2}\right).$$

If we raise the key, $V = V''$

$$\text{and } D'' = k\,(V' - V'')\left(\frac{V' - V''}{2}\right)$$

$$= \frac{k}{2}\,(V' - V'')^2;$$

$$D' - D'' = k\,(V' - V'')\,(V''' - V'')$$

Now if C is the instantaneous current $V' - V'' = C\,r$ since r is non-inductive.

$$\therefore \frac{D' - D''}{r\,k} = C\,(V''' - V'') = \text{instantaneous power given}$$

to inductive circuit.

$\therefore$ The mean value of the power given to the inductive circuit is the mean value of $\frac{1}{r\,k}\,(D' - D'')$ and this is in the form of a difference; hence we may apply and say simply the mean value of the power given to the inductive circuit is $\frac{1}{r\,k}\,(D_1 - D_2)$.

So far as I know these are the only satisfactory methods yet suggested for the measurement of the watts developed by an actual alternator as built to-day.

UNDERGROUND MAINS IN PARIS.

ACCORDING to *L'Industrie Electrique*, the Compagnie Continentale Edison has had difficulties with its underground mains. The type of conduit originally adopted was very similar to the Crompton system, but want of space precluded its universal use. The company, therefore, looked out for a system which, while occupying less space, should still allow of bare copper conductors being run everywhere. At this juncture Jacob Frères, of Pouilly-sur-Saône, suggested rectangular earthenware troughs. These were used in places, and at first gave good results. After a time, however, the insulation fell, owing to infiltration and chemical action, and the Edison Company has now reverted to its first plan.

THEORETICAL ELEMENTS OF ELECTRO-DYNAMIC MACHINERY.[1]—I.

BY

A. E. Kennelly

MAGNETISM is the science that deals with a series of phenomena whose ultimate nature is unknown, but which result from, or are at least accompanied by, a particular kind of stress. This stress may reside in matter or in the air-pump vacuum. The magnetic metals, iron, nickel, and cobalt, when submitted to this stress, not only intensify it in their own substances, but are strained in such a manner as to sustain the stress independently to a greater or less degree after the existing cause has been withdrawn. In other words they become magnetic and remain magnetized.

The only known sources of magnetic action are three, viz., electric currents, electrical charges in translatory motion, and magnets.

Any magnetized space, or region pervaded by magnetic stress is a "magnetic field," but the term is commonly applied to the space which separates the poles of an electromagnet. The existence of stress in the field is evidenced in several ways:

1. By the magnetic attraction or repulsion of magnetized substances introduced within the field.
2. By the influence exerted on the molecular structure or molecular motion of a number of transparent substances whereby the plane of propagation of luminous waves is rotated in traversing them.
3. By the electromagnetic energy which is found to be absorbed by the medium during the establishment of a magnetic field, stored there while the field is maintained, and released at its subsidence.
4. By the electromotive forces that are found to be generated in matter moved through the field.

These experimental evidences point to the action of magnetic stress pervading the magnetized medium. Moreover the stress never terminates at an intersecting boundary, but follows closed paths. A line of stress is a closed loop like an endless chain. If a small compass-needle were introduced into a magnetic field, and kept advancing from point to point in the direction it assumed at each instant, it would finally return to the position from which it started. This can only be shown in the case of fields established by electric currents in wires, or coils of wire, as the needle could not complete its circuit through the mass of an iron magnet. The circuital distribution of the stress indicates its appurtenance to the category of fluxes. That is to say, in any magnet, or magnetized region, there is a distribution of influence analogous to the flow of current in an electric circuit, or the flow of water in a closed pipe or re-entering channel. The marked distinction, however, between the flow of magnetism, and the flow of electricity or of fluid material, lies in the fact that no work is done and no energy exchanged in the passage of the magnetic current. The electric current and the moving liquid encounter resistance and develop heat in moving against that resistance, but the magnetic flux acts as electrical currents or material currents might act if unchecked by resistance but regulated in quantity by other limitations; and if water were itself frictionless and were set circulating in a closed frictionless pipe, it would necessarily continue in perpetual motion. It of course by no means follows that any circulating motion of matter or of ether actually takes place in a magnetic circuit. That there is a possibility of such motion is a consideration left to the theory of the ultimate and fundamental nature and origin of magnetism. All that is essential to the conception of a magnetic flux is a continuous stress acting along a closed path or circuit, such that a single magnetic pole (if such could exist alone, or let us say as the nearest representation in fact, one pole of a long bar magnet) were introduced into this path it would be continually urged round the circuit.

Flux in a magnetic circuit, just as in a hydrostatic, or electric circuit, possesses at each point intensity as well as direction, and can therefore be completely specified by a vector. According to the conventions etablished in the absolute C. G. S. system, a field of unit intensity will exert unit pull or one dyne, upon an isolated unit magnetic pole introduced therein. The intensity of the earth's magnetic flux is approximately 0.6 unit in the open country around New York, and consequently, a single north-seeking or unit pole suspended in that neighborhood would be drawn downwards in the direction of the dipping needle with a force of 0.6 dyne, which would represent the weight of nearly 0.6 milligramme (a dyne being about 2 per cent. greater than the earth's gravitation pull on a milligramme of matter). Practically it is impossible to obtain an isolated unit pole, but it is quite possible to measure the pull exerted by a magnetic field upon some definite system of electric currents or magnets, and to deduce what the corresponding pull would be on a unit magnetic pole. This would be the numerical intensity of the flux in the neighborhood of the point considered. Flux intensity is denoted by the symbol B, and is, strictly speaking, a vector denoting direction as well as magnitude.

The direction of a magnetic flux is the direction in which it would move or tend to move a free north-seeking pole. The north or blue end of a small compass needle points in the direction of the field surrounding it. According to this convention it follows that the earth's flux is from the geographical south towards the geographical north pole. Also, to follow the direction of a flux, is to move along it in a positive direction, while to oppose it is to move negatively.

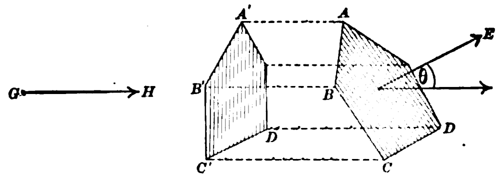


FIG. 1.

The total quantity of flux that will pass through a given normal plane area, is the product of that area and the intensity when the latter is uniform. For example, a plane area of say 150 sq. cms. held near New York perpendicularly to the direction of the dipping needle will contain 150 x 0.6, or 90 units of flux. In ordinary language it will contain 90 lines of force or of induction. The word induction, however, from frequent misapplication is apt to be so ambiguous that it is advantageous to dispense with it in this sense.

If the intensity varies from point to point, the total flux will be the average intensity over the surface multiplied into the area. If the plane area does not intersect the flux at right angles the flux enclosed will be the average intensity multiplied by the area of the boundary as projected on a plane intersecting perpendicularly, which might be termed the equivalent normal area. This is shown in Fig. 1 where ABCD represents an arbitrary boundary drawn on a plane surface whose normal E makes an angle θ with the vector GH, and this vector represents the uniform flux intensity in direction and magnitude. The total flux enclosed by ABCD will be the product of the length GH into the area A' B' C' D' which is the projection of ABCD on a plane normal to GH. Calling the area ABCD a, φ the total flux, and B the intensity, it is evident that

$$\varphi = a\, B \cos \theta$$

Finally if B, instead of being uniform throughout the space covered by the area, varies from point to point, the total flux could be found by dividing the areas into a sufficiently large number of small portions, determining the values of θ and B for each. By taking the area small enough, θ and B would be more and more nearly uniform within the limits of each, and the flux through each could then be determined separately. The sum of these fluxes would be the total flux enclosed by the whole boundary area. In other words the total flux would be the surface integral of the normal intensity all over the area as expressed by the equation

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$$\varphi = -\int S.\ Bn\ ds.$$

This general result is independent of the form of the surface round which the boundary is described. This surface may be plane, warped, or convoluted.

As an example, consider the spherical surface represented in Fig. 2. Let this surface be definitely located in any permanent field—in a flux that does not vary with time—but which may be quite irregular in intensity. We may assume that the vector B is known or can be determined for every point. Draw any closed line CDEG round the sphere. Then if this sphere does not enclose any source of magnetism—current or magnet—we may follow out the plan above indicated and take the surface integral of flux: (1) over the lesser spherical area CDEGH; (2) over the greater spherical area CDEGK; (3) over a surface stretched tightly across the boundary; or (4) over any conceivable surface into which the diaphragm CDEG could be expanded. The result will in each case be the same total flux, if due precaution be taken to attach + signs to emerging + flux, and — to an entering + flux. Any element of flux not passing through the boundary must then cut the surface an even number of times half in entrances and half in emergences, and the summation of these elements having opposite signs will cancel out from the result in pairs.

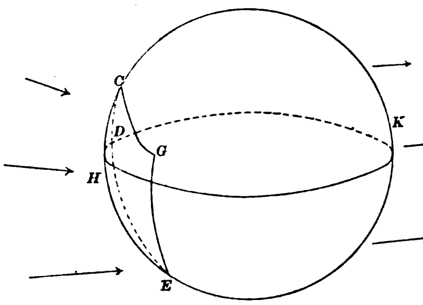

FIG. 2.

This proposition, capable of indirect experimental verification, is tantamount to the statement that magnetic flux neither expands nor condenses in its passage through bodies, however its direction or intensity may vary. Because the flux which is steady in regard to time must be entering into and emerging from any portion of space at the same rate, unless at that moment, expansion, condensation, generation, or annihilation be taking place within the confines. In the above instance of Fig. 2, it is evident that the flux which enters the area CDEG in the direction of the arrows must be issuing from the volume CDEGK at the same rate if accumulation or dissipation is not at work within, and the quantity which in any given time issues from the spherical surface without having also entered there must have come in through the boundary CDEG. In this respect magnetic flux behaves like the flow of an incompressible fluid.

"CANNOT AFFORD TO MISS ONE."

A SUPERINTENDENT of construction for one of the parent companies, who happens to be at work just now in Pennsylvania, writes us to give his address, and says: "I have not received last week's copy of your paper. It is so valuable to me I cannot afford to lose even one."

THE ELECTRIC MOTOR IN AGRICULTURAL WORK.

BY

A. A. Denton

IN a previous communication,[1] the writer pointed out the great desirability of employing electricity as a general motive power in agricultural work, and showed how, by the use of the electric motor larger crops could be sowed and harvested than are now attempted and with a reduction in cost to the farmer. Since then an experimental trial of a 5 h. p. motor has been made here, simply to learn the points of the motor, and to learn the difficulties which may be met in adapting it to field work.

When the experiment with the electric motor was begun here, it was supposed that the difficulty of a movable wire connection of the motor with the dynamo would be formidable. It is believed that this difficulty can easily be met; the motor, as it moves over the field, easily moves the trolley line. The difficulty of traction, or adhesion of the driving wheel of the motor car, is greater, for a 25 h. p. motor weighs no more than one good horse, and exerts far greater pull. It is obviously not desirable to add dead weight to increase traction, but whenever a difficulty is clearly recognized and measured, ways are found to obviate it; this is the history of all progress.

There is now very great interest in the matter of utilizing mechanical power in cultivating the great prairies of the West. Several steam plows are now being set up in this State, and it is hoped that accurate data in regard to the use of direct traction steam plows may be had this season. So far as I am able to learn, indicator cards of the engine and dynamometer tests of the plow-gang have never been taken to show the proportion of useful effect to the power developed in the steam plow.

Senator Peffer, of this State, has introduced a bill to provide for the establishment of an agricultural power experiment station by the Government, in which an effort may be made to determine the relative values of the different motors on the great grain-growing farms of the plains. It seems that the Department of Agriculture may, by employing expert skill and sufficient means, determine points of value to the country. Senator Peffer's bill has been referred to the Committee on Agriculture and Forestry, and will soon be considered by that committee.

The Senator would be pleased to have the points of the electric motor, with reference to its supposed fitness for agricultural work, to use in argument before the committee. The experience of your readers and their knowledge of power machines, of the comparative efficiency of animal power and of the electric motor in street railway work, may materially aid the Senator in securing the establishment of an agricultural experiment power station. Let THE ELECTRICAL ENGINEER aid in this matter, and oblige the hundreds of thousands who are interested in the solution of the problem of power on the farm. James Watt said to the King of England, "I have what every subject of your majesty wants—power."

Western agriculture requires power by which one man may accomplish as much as many men in the old way—power to cut wider and deeper and swifter furrows at less cost than in the old way. Manufactures and commerce and mining have the advantage of ample and cheap power; agriculture alone is limited to animal power. If the motor may be be adapted to farm work, Western agriculture will enter a new era. The great plains appear to have been planned for cultivation of the soil on a large scale.

DEPARTMENT OF AGRICULTURE, STERLING, KAN.

"MY OPINION OF YOUR PAPER."

A READER in Baltimore writes us: "I would state that I *take* several electrical papers including yours; I *read* the ENGINEER."

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[1] THE ELECTRICAL ENGINEER, Dec. 30, 1891.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them, are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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VOL. XIII. NEW YORK, APRIL 20, 1892. NO. 207.

The history of progress is full of examples of able men following a wrong road from ascribing effects to that which in the end has proved not to be the cause.—Coleman Sellers.

WIRING INSPECTION BY MUNICIPAL AUTHORITIES.

THE passage of a bill [Assembly Bill, No. 778,] in the New York State Legislature creating a Bureau of Fire-Alarm, Telegraph and Electric Appliances for the city of New York deserves more than passing notice. The scope of this bill will be best understood by the following abstract relating to the powers and duties of those in charge of the Bureau:

> Said Bureau shall have charge of the construction, care and management of the fire-alarm and telegraph system of said department. Said Bureau is also charged with the duty of enforcing all the provisions of this title, and all rules, regulations, orders and requirements made thereunder. In regard to electrical wires or currents for furnishing light, heat or power for any building in this city, and in regard to the arrangements and use of said light, heat and power, the Board of Fire Commissioners is hereby authorized, and required, to make rules and regulations in regard to electric wires and appliances and currents for furnishing light, heat or power, which may be introduced into or placed in any building in the said city. * * * Before any such wires, currents or appliances are used or operated for any purpose, such compliance shall be duly certified, in writing, by the superintendent of fire-alarm, telegraph and electrical appliances.

Any violation of this law is punishable with a fine of $50, and if the violation be continued a penalty of $250 is imposed.

The legislation embodied in this bill is the first, in this country, which has imposed upon a municipal bureau the obligation of inspecting and passing upon the interior wiring of buildings. Up to the present time such inspection and approval has been left to the various boards of fire underwriters throughout the country, and the inauguration of this new order of things, in this city at least, may bring about a state of affairs requiring the serious attention of all engaged in electric lighting and the distribution of electric energy generally. The rules which the new bureau is called upon to frame will evidently have to be fashioned much after those already in vogue among the fire underwriters, and with few modifications such will serve excellently. It is evident, however, that the Board of Fire Underwriters will maintain their own inspections unless they are thoroughly satisfied that the work of the municipal bureau is of such a character as to be beyond reproach. In any event, the person placed in charge by the municipal bureau ought to possess the highest ability and integrity, and enjoy the confidence, not only of his own chief, but of the Board of Fire Underwriters as well. Without a cordial understanding between these two bodies, much confusion and not little hardship is bound to follow upon the inauguration of the city electrical bureau of inspection. It is greatly to be desired that the selection of the proper official be made with this object in view and "party politics" be completely put aside. As it is more than likely that the course pursued in New York will be followed in other cities, it is doubly desirable to have this matter successfully inaugurated. Properly conducted, such a bureau ought to be of the greatest benefit, but in incompetent hands it would be a curse to the industry.

Another point to be determined is the scope of the duties of the bureau. We have always been under the impression that the Board of Electrical Control, which has just renewed its lease of office for another year, has claimed and exercised some sort of supervision over central station plants and circuits.

A FAILURE WITH A LESSON IN IT.

THROUGH excess of zeal accompanied by lack of discretion, a hunter once upon a time found himself in the position of having an exceedingly lively tiger by the tail, and was thereupon confronted with the awful conundrum, as to whether he would do worse to hold on or to let go. This appears to be substantially the situation which now confronts the London Electric Supply Corporation, organized four years ago to produce and distribute electricity on a colossal scale, as if, like the brewing and sale of beer, it was simply a question of a sufficiency of working capital. Placing themselves unreservedly in the hands of a single adviser—a young man possessing a degree of ability which cannot be questioned, but without that experience which tends to sober the judgment and to chasten undue self-confidence, and who was forthwith installed in the diverse, not to say conflicting positions, of engineer, inventor, patentee and contractor—the shareholders launched forth into one of the most colossal undertakings of the century, regardless alike of the teachings of experience and of the predictions of conservative electrical engineers. As the chairman at the recent annual meeting of the company expressed it, "The board had relied on the scientists, who had been clever enough to satisfy some very hard-headed men of business to adopt their views and to find money to carry them out." The scheme thus attempted to be carried out is familiar to most of our readers, and need not be described in detail. Two gigantic dynamos, having armatures 45 feet in diameter, driven by 10,000 h. p. engines, were to transmit current at a pressure of 10,000 volts, several miles into the heart of London, to supply over 2,000,000 16 candle incandescent lamps. On this extraordinary undertaking nearly $4,000,000 has thus far been expended, and although the company began to supply current over three years ago, the output to-day has reached only 36,000 lamps. The results of operations of the past year show receipts in round numbers of $77,000, and expenses of $112,000, a net deficit of $35,000. By way of comment, on this exhibit, as the Irish judge said, "The only thing requisite is silence, and as little of that as possible." One cannot however but admire the true Anglo-Saxon pluck with which the shareholders of this ill-starred undertaking have stood by their colors, and still stand by them, inasmuch as they now propose to mortgage the plant for $250,000 more, and as one director remarked, "try the experiment to the bitter end." Having abandoned the enormous dynamos referred to which are still incomplete, it is proposed to enlarge the plant as soon as possible to 90,000 lamps, using the 1,250 h. p. dynamos now in service. One cannot but hope that the undertaking may be attended with at least a reasonable degree of success. Such splendid courage deserves a happier issue than has so far attended the venture.

WHO DID THIS?

THE Legislature and Governor who passed and approved the recent bill for setting up a trotting-course in Central Park (just now repealed in reluctant obedience to the indignant demand of the people of this city) may attempt almost any imaginable enormity of legislation. Scarcely anything thus far attempted has been worse than the act "To authorize the East River Gas Company of Long Island City to supply gas and electricity in the city of New York," introduced by Assemblyman Byrne March 15, and which has been passed by both houses of the Legislature and now awaits the action of the amiable but plastic gentleman who sits in the Governor's chair.

Below is the first section of the bill:

> SEC. 1. The East River Gas Company of Long Island City shall have the right, and it is hereby empowered, to supply gas and electricity in the city of New York, and for that purpose is hereby authorized, without other or further authority of law or ordinance, to lay and maintain requisite conductors, mains and pipes through and under any streets, avenues or public places of such city. For the purpose aforesaid such corporation shall have the right, and it is hereby empowered, to lay and maintain such conductors, mains and pipes under and across the East River and across any intervening land belonging to the city of New York, or to private persons, at such places as it may determine: Provided, however, that such conductors, mains or pipes shall be so laid and maintained as not to obstruct or impair navigation, commerce or anchorage of any navigable waters without the consent of the Secretary of War. And such corporation shall have the right, and it is hereby empowered, to acquire by condemnation or purchase such real property, public or private, or right, interest or easement therein, for the laying and maintaining of its mains, pipes and conductors, as may be necessary in the exercise of the powers hereby conferred. Such property when so acquired, shall be deemed to have been acquired and held as and for a public use.

The remaining sections provide for the condemnation of property and authorize the leasing by the Long Island Gas Co. of other companies or properties; thus preparing the way to the formation of a huge monopoly.

The reputation of Long Island City is somewhat unsavory in the nostrils of most people within some miles of it. It is both physically and politically malodorous. There is a distinct effluvium of spoils in the scheme under notice. But we take leave to doubt whether so considerable and comprehensive a plan for plundering the city of New York generally, and existing electric lighting companies in particular, was concocted on the borders of Newtown Creek. "The voice is the voice of Jacob but the hand is the hand of Esau." Tammany, directly or indirectly, is more than likely to be the instigator and participant of the business.

It is quite unnecessary to point out in detail the menace to the public, to the existing subway company and to electric lighting companies now serving public and private consumers.

LIGHTING THE WORLD'S FAIR.

THE course of events in regard to the award of contracts for lighting the World's Fair, as well as for the power plant, has been somewhat extraordinary, and on the whole the situation is one to be regretted. In the first place, the management of the Fair appear to have had little idea as to the cost of electrical plant, and hence were talking about thousands of horse power and hundreds of thousands of lamps in a way that was utterly absurd. But when it came to bidding on the smaller figures dictated by prudent advisers of the management, another development not less strange was seen. The price for the use and maintenance of 5,000 or 6,000 arc lamps was cut from $38.50 down to $20 per lamp, and now the price of incandescents has been cut from $18.50 to $5.95. This latter reduction on a total of 93,044 lamps, makes a saving of $1,200,000 out of a proposed $1,720,000, to which might be added a saving of about $100,000 on the arc lighting!

We note some very vigorous comments in the Chicago newspapers on these figures, and must admit that a most unfortunate showing has been made. Such an enormous reduction can only be interpreted by the public to mean either that a tremendous profit was sought for in the first instance or else that the work has now been taken at a terrible loss to keep out competitors. Both aspects of the case give a bad impression.

The same criticism is more or less pertinent as to the power plant, where, it is said, equally inflated estimates were in contemplation. As we understand it, a large part of the contract for use of generators, etc., has been allotted at $2.50, a figure far below what was asked by some parties. It is absolutely certain that the company taking the work at $2.50 per horse power can make no profit. Probably all that it hopes for, or wanted, is a return in the advertising it will secure, and such a return no one can grudge it.

It seems to us a very great pity that at the outset the Fair management were led to believe that electric light and power cost nothing, or that even if they did involve expense they would be furnished on a "free lunch" basis.

Mutual Action of Vacuum Discharge Streamers.

WE print elsewhere the research undertaken by Dr. M. I. Pupin on the action of vacuum discharge streamers upon each other. It is worthy of attentive study on account of the light which it may throw on the actions that determine the formation of the solar corona. The effects obtained resemble in many respects, though on a small scale, the repulsive actions which some authorities ascribe to the streamers in the sun's corona; but Dr. Pupin does not accept without reserve the explanation, hitherto given, of the repulsion as due to electrostatic action.

THE WOOD INCANDESCENT DYNAMO.

One of the first to enter the field of arc lighting was Mr. James J. Wood whose arc machine still maintains a prominent position among the successful arc dynamos, and who has succeeded in operating more lamps from one machine than have been attained probably by any other designer.

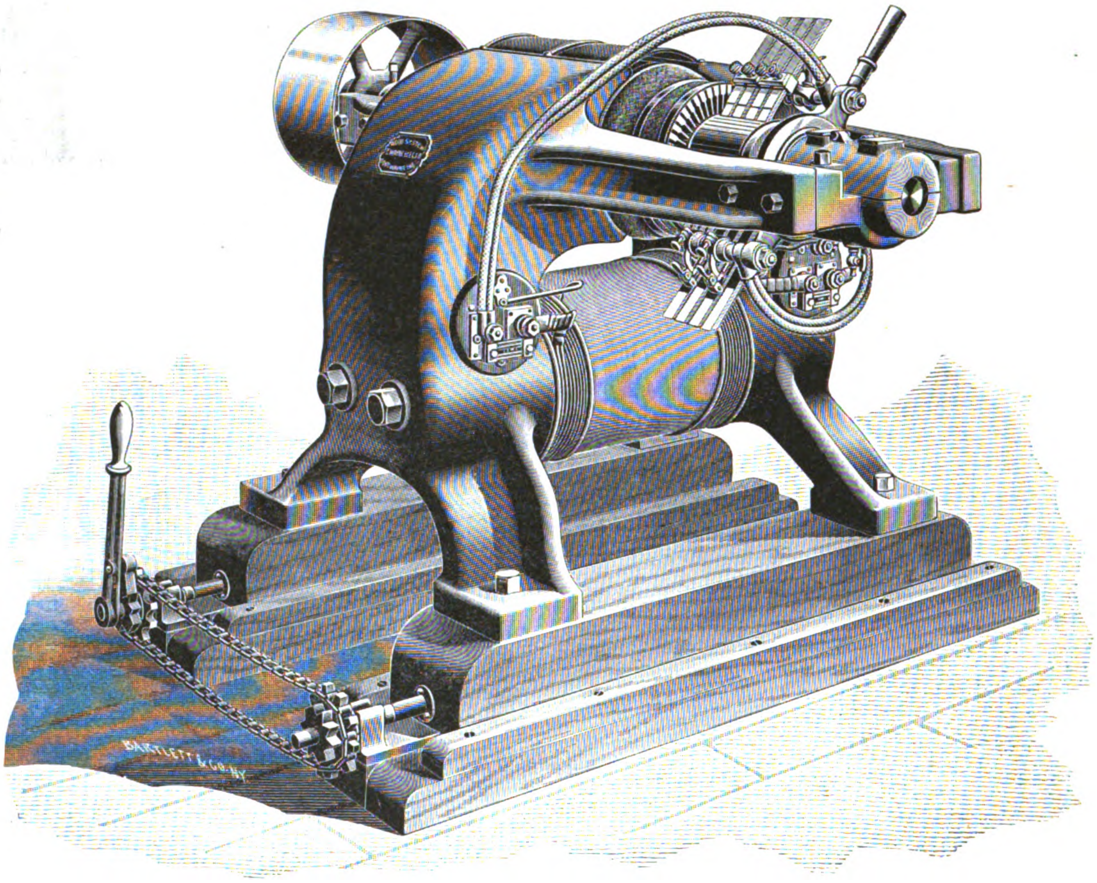
More recently Mr. Wood has devoted his attention to the designing of an incandescent machine, which is built by the Fort Wayne Electric Company, and is illustrated in the accompanying engraving. The magnetic frame involves but a single circuit with only two joints, the exciting coils being wound on a wrought-iron core. The machine is compound wound for constant potential and regulates perfectly at all loads with a high efficiency.

The weight of the Wood dynamo for its output is exceedingly low, as will be evident from the following data which refers to a 500-light machine :

Weight of wire on armature	58	pounds.
" " field	133	"
Total weight of machine	3,600	"

This gives a weight of only 191 pounds of copper for a machine having a capacity of over 30,000 watts, and a weight of only .12 pound total per watt of output.

The machine is provided with self-contained multiple fuses for each end of the circuit and also with an equalizing connection. The latter is intended for connecting several machines in multiple, and is so placed in the circuit that one machine will tend to equalize the potential of its neighbors; or, in other words, keep all the machines working at the same potential, independent of the load. In order to facilitate the running of the machine it is mounted on a patent anti-friction, insulating and sliding base, which is so arranged that the motion is positive in either direction whether the belt be tightened or slackened. The workmanship of the machine throughout is of the usual excellence found in the machines designed by Mr. Wood, all parts being made to gauge and interchangeable.



The Wood Incandescent Dynamo.

VARYING PROPERTIES OF OIL AS AN INSULATOR.

The experiments on high-tension discharges of high frequencies described in The Electrical Engineer, by Prof. Elihu Thomson, besides illustrating the simple methods required to obtain brilliant discharge effects seemed to point to some remarkable properties of oil as an insulator, and Professor Thomson has referred to the great future which the application of oil insulation opened up in the field of high-tension transmission. Continued experiment, however, has developed facts which have led Prof. Thomson to modify his views somewhat on the subject of oil insulation, and in reply to a letter on this subject he writes us as follows :

"It is more than probable that I shall have to make a revision of my views as stated in relation to oil as an insulator. In conducting my experiments I have been testing the striking distance in oil with varying periodicities and with varying forms of discharge electrodes, and I find that the results would seem to indicate that with an oil such as we have been using for the insulation of the high-period discharges at enormously high voltages, there is a much less resistance to discharges of the ordinary alternating character at low rates, such as 125 periods, or 250 alternations.

"I find that considerable distances in oil are punctured. In fact, the distances in some cases are quite comparable with the distance which the discharge leaps in air. I find, also, that with high-period currents, such as I get from my high-period alternating machine giving from 3,000 to 5,000 or more alternations per second, different effects are obtained; though the experiments are not yet complete.

"One of the most curious things noticed in the conduct of the experiments has been the time which it takes to break down the oil. For example, for a short contact of a half second or so, oil even in fairly thin layers seems to insulate, but if the contact be continued over some seconds, or even to half a minute or more, the discharge may break through the insulating layer. The time taken seems to increase with the distance of the electrodes apart under the oil. I have given these preliminary results hoping to investigate the subject pretty thoroughly and to really understand something about oil as an insulator before we get through."

ON THE ACTION OF VACUUM DISCHARGE STREAMERS UPON EACH OTHER.[1]

BY M. I. PUPIN, PH. D., COLUMBIA COLLEGE.

VARIOUS phenomena which I observed in the course of an investigation on the coronal effects produced by electrical discharges through rarefied gases, led me to the belief that under certain conditions two electric current filaments in a rarefied gas may act upon each other oppositely to the direction of their mutual electro-dynamic action, and that this additional action may sometimes be far predominant over the electro-dynamic action; that is to say, we have a strong repulsion where electro-dynamic action would produce an attraction. A brief account of these investigations was given on Feb. 8, before the Astronomical Section of the New York Academy of Sciences. The following paper is limited to the description of the experiments by means of which the existence of the above-mentioned action was definitely proved.

Fig. 1 represents the apparatus first employed. Four glass bulbs, A, B, C, D, each having a capacity of about a litre, are connected by four glass tubes of small bore to a glass reservoir E. A stop-cock F serves to connect the apparatus to a mercury pump. The reservoir has a diameter of 10 cm. and a length of 22 cm. The mouths *e*, *f*, *g*, *h*, of the four narrow-bore tubes form a square whose side is 10 cm. long. The bulbs are covered with tinfoil and the tinfoil is then well coated with paraffine. Each tinfoil covering has a well-insulated copper wire attached to it.

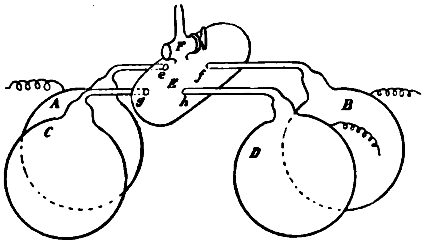


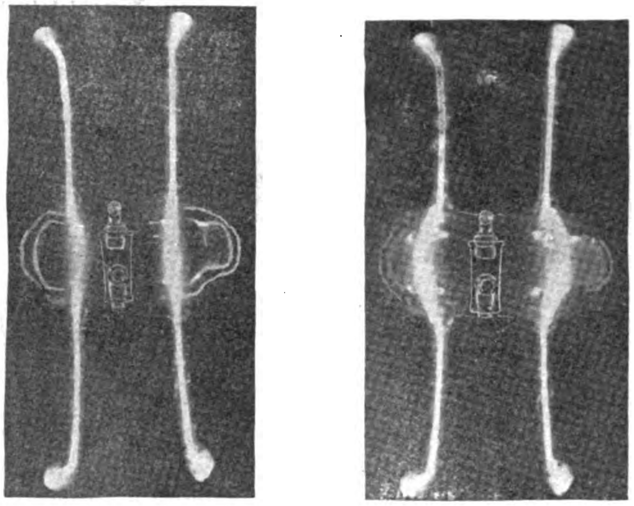
FIG. 1.

After producing a 2 mm. vacuum in the apparatus the bulbs A and B were connected to the secondary poles of a small Ritchie induction coil, whose primary was fed by an alternating current of 125 periods per second. The electromotive force in the secondary coil was varied by varying the current in the primary; this was done by means of a resistance box in the primary circuit. The electric flow between the bulbs is, of course, due to the condenser effect between the tinfoils and the vacuum.

At the pressure of 2 mm. the discharge was easy, steady and very diffuse along its path through the reservoir. Disconnecting AB and connecting CD to the induction coil the discharge was the same in character as before. Connecting both pairs of bulbs in parallel to the induction coil, that is, the bulbs A and C to one pole and B and D to the other pole, the two discharges, going on simultaneously, were the same in character as before, except that they were somewhat convex towards each other.

The pressure was then increased by turning the stop-cock once around and allowing some air to get in. The discharges were less diffuse but more luminous, and less convex toward each other. With the increase of pressure the discharges became less and less diffuse and their convexity towards each other diminished until, when a certain gas pressure was reached, it disappeared. At this point the discharges were very little diffuse and when allowed to pass through the reservoir simultaneously they remained rectilinear, but somewhat unsteady, oscillating quite appreciably about their rectilinear paths through the reservoir, but the oscillations were always in the plane common to their rectilinear paths.

The pressure was still increased by turning the stop-cock once around and allowing some more air to get in. The discharges became still less diffuse along their path through the reservoir and when allowed to pass one at a time they were quite steady and rectilinear. Both being allowed to pass through the reservoir simultaneously they were appreciably concave toward each other, but the concave arcs were in the plane passing through their shortest path in the reservoir. There was evidently a repulsive force acting between the discharges. This repulsive force increased continually with the increase of pressure in the vacuum, but with the increase of the force the steadiness of the discharges along their paths through the reservoir when they were both passing simultaneously gradually diminished. Fig. 3 is a photograph of the discharges when taking place simultaneously in a vacuum in which the repulsive force just described was moderate. Fig 2 is a photograph of the same discharges, but when taking place one at a time. Fig. 2 indicates that there is a repulsion between the discharge and the nearest wall of the reservoir, but this repulsion is very small in comparison to the repulsion acting between the streamers, when they take place simultaneously, as Fig. 3 indicates. The photographs were taken by very short (1 to 1½ second) exposure, so strong is the luminosity of these discharges. They were taken when the repulsion was moderate, because when the repulsion is very strong the discharges oscillate very rapidly, so that they could not be well photographed with the apparatus employed. When the repulsion was so strong as to cause the streamers to curve way out and from time to time strike the nearest wall of the reservoir, the vibrations became very violent every time the streamers struck against the walls. They rebounded against the walls just as if they were luminous vibrating strings.



FIGS. 2 AND 3.

At this pressure in the vacuum it was very difficult to start the discharge and I had to strain the alternating machine and the induction coil to their utmost to make the start.[1] But when once started the discharge continues without any interruption even if the potential at the tinfoils is lowered 15 to 20 per cent.

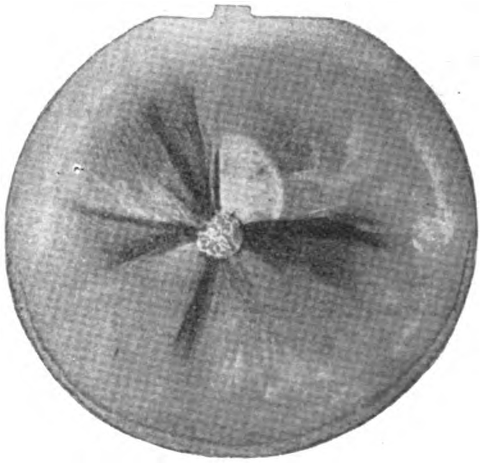


FIG. 4.

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[1] From the *American Journal of Science*, Vol. XLIII, April, 1892.

[1] A gentle touch of the apparatus with a conductor will sometimes start the discharge at once when all other means of making this start fail.

The rate at which the temperature of these discharges increased with the increase of pressure in the vacuum seems to be much more rapid than the increase of the pressure; (the impressed E. M. F., of course has to be increased with the pressure) and with the increase of the temperature the luminosity of the discharge increased also. With the increase of luminosity the color of the discharge changed from the pink color, which is the characteristic color of the ordinary Geissler tube discharges through rarefied air, to a color which inclined more and more toward the white. With the increase of the pressure the diffuseness of the discharge disappeared, but instead of the diffuse pink color there appeared a beautiful green phosphorescent light which filled the whole reservoir. This phosphorescent light is so strong, that even an almost instantaneous exposure is sufficient to give it time to act upon the sensitive plate, as appears from the photographs in Figs. 2 and 3. At some future date I shall describe experiments which seem to be a strong proof that phosphorescence produced by electrical discharges depends on the temperature and only in so far on quantity of the discharge and on the vacuum, as the temperature of the discharge depends on them. The investigations of Crookes, Goldstein, and others lead to the conclusion that a high vacuum with its cathode rays is most favorable if not indispensable to the development of strong phosphorescence. In my experiments a good vacuum (of about 2mm.) gave no phosphorescence whatever, whereas a poor vacuum (even with as high a pressure as 100 mm.) gave very strong phosphorescence, and that, too, not only in places where the discharge struck the walls of the vessel, but also in places which were far away from the discharge. Presently I shall describe an experiment which shows that the gas as well as the glass becomes strongly phosphorescent. My observations cannot, therefore, be well reconciled to those of Crookes, Goldstein, etc., unless the cathode rays be supposed to be very thin and very hot discharge filaments. I have several experimental facts which speak in favor of this hypothesis, but a discussion of them would lead me beyond the limits of this paper.

I find that some astrophysicists assume the existence of a repulsive force acting between the streamers of the solar corona; it was the peculiar behavior of the corona-like vacuum discharges which, in addition to other phenomena that came under my observation, forced me to assume that repulsive forces must be active between the filaments of these discharges, although at that time I was perfectly ignorant of the details of the various electrical theories of the solar corona. The streamers of these discharges are very unsteady and very much split up when the vacuum is poor. A photograph of a discharge of this kind is given, Fig. 4.[1] As the vacuum improves, the corona-like discharges become a great deal steadier, less torn up and quite diffuse, but never uniformly distributed over the whole spherical electrode. Fig. 5 represents the photograph of a discharge in the vacuum of about 20 mm. pressure. These photographs belong to my collection of photographs of corona-like vacuum discharges, an account of which I expect to give at some future time.

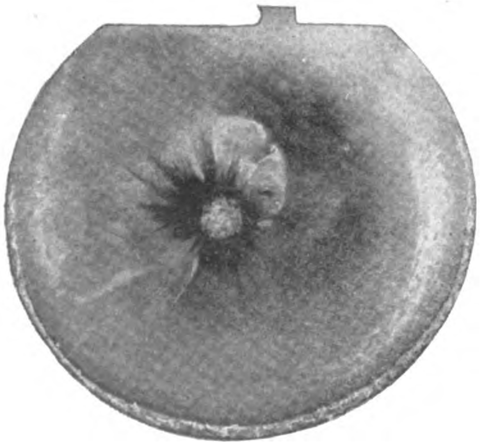

FIG. 5.

The question arose then, naturally, what is the cause of this repulsion? Electrostatic action suggested itself first, of course. But various observations which I made during my investigations on vacuum discharges made me favor another view, the view, namely, that the repulsive force between vacuum discharge streamers is due to a strain in the vacuum produced by the peculiar distribution of the gas pressure resulting from the peculiar distribution of temperature. If this view is correct then there should be no action between two vacuum streamers passing in two separated vacua. This suggested the following experiment:

Investigate the action of two discharge streamers upon each other when two separate discharge reservoirs are employed. Fig. 6 represents the apparatus (with its dimensions in cm. marked), containing one of the reservoirs, two of which were placed side by side in the experiment. The bore of the capillary tubes *e*, *c*, *d*, *f*, was about 1.5 mm. The bulbs AB were coated with tinfoil, and the whole arrangement was the same as in the experiments with the apparatus given in Fig. 1. The two apparatuses communicated with each other by means of a stop-cock, so that the pressure was the same in each. The discharge in one apparatus did not influence the discharge in the other, no matter what the pressure was, up to the limit at which I could still obtain a discharge; which was about 60 mm. From this I conclude that the repulsion which I observed in the previous experiments was probably not due to electrostatic action. The probability of the correctness of the other view is therefore considerably strengthened.

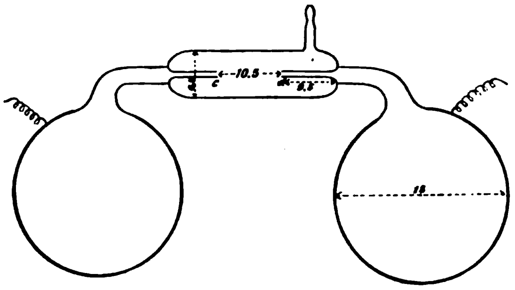

FIG. 6.

The apparatus for this experiment was constructed with two other objects in view, which ought to be mentioned here.

1st. To locate the phosphorescence. In this I was quite successful. It surrounded the hottest parts of the discharge, and therefore it was most intense in the narrow parts of the apparatus. Within the reservoir it extended from *c* to *d* in form of something like an ellipsoid of revolution, with the extremities of its longest axis at *c* and *d*, and at times this ellipsoid did not fill out the reservoir at all, which proves that the phosphorescent light in this part of the apparatus is due to the phosphorescence of the rarefied air and not to the phosphorescence of the glass, although in the narrower parts of the apparatus where the hot discharge was very near the glass the glass was also phosphorescent.

2d. To study what I call the ramification of the discharge. As soon as the pressure reached a certain limit, the luminosity in the bulbs (which at low pressures was more or less uniformly diffused throughout the bulbs) become streaked, and at still higher pressures the whole discharge in its path through the bulbs divided itself into a number of distinct streamers, the number of streamers diminishing with the increase of pressure; given pressures produced invariably the same number of streamers. In this experiment I did not succeed in reducing the number of these streamers to less than two. The streamers rotated more or less uniformly in one direction or the other. The angular velocity of rotation seemed to increase considerably with the current of the discharge.

An exhausted glass bulb without electrodes when brought into the vicinity of these discharges emits a faint yellowish light which looks very much like the light of some forms of the aurora borealis. The bulb seems to remain perfectly cool. Lack of time and facilities have prevented me from determining the spectrum of this cold glow.

My thanks are due to Professors W. P. Trowbridge and J. K. Rees for the interest which they took in my work; also to Mr. Mann, of the Astronomical Observatory, for the very valuable service which he rendered to me in photographing these discharges. I hope to continue this work with improved facilities as soon as time will permit.

Columbia College, February, 1892, Department of Electrical Engineering.

ELECTRICAL METHODS OF ANALYSIS.[1]

ELECTROLYTICAL methods of analysis have long been in use for certain restricted purposes by the generality of chemists, and have been adopted as a kind of cult by a few enthusiasts in Germany and America, but until quite lately electrical methods pure and simple have been almost unknown. We recorded an attempt of the kind a short time ago which was based on the alteration in conductivity of milk caused by the addition of water, and pointed out that the analyst using this process would be dependent upon the courtesy of the milk dealer to inform him of the source whence the water was derived and to provide a sample for examination. A more feasible plan, resting on the same principle, is now suggested for determining the extent to which glass is attacked by water. According to popular belief glass is entirely unaffected by "chemicals" of all kinds, and still less is water supposed to have any action upon it. So far from this being true, it is very appreciably acted upon by the most diverse solutions, and notably by water itself, and it is frequently a matter of importance to determine the degree of vigor of this action, and to discover which composition is best suited for a glass intended to resist it as far as possible. It was found that the increase of conductivity of water contained in a glass vessel was in direct proportion to the corrosion of the glass, and the net results of the experiments served to confirm the observation previously made by other methods that the extent to which the glass was attacked increased with the temperature, and was greater with a new vessel than with one that had been used before. That the method is accurate appears probable from the fact that the deductions drawn by its means agree with those obtained by the very delicate process of titration devised by Mylius and Forster. The method of determining the chemical compositions of solutions by the observation of their physical properties has already done good service, and has led to the devising of such instruments as the refractometer and the polarimeter, and the time may yet come when the resistance box and the Wheatstone bridge may equally be of specific if not of general utility.

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[1] Figs. 4 and 5 are negative prints; *i. e.*, in the original the blacks appear as whites, and vice versa.

[1] *Industries.*

DEWEY'S INDUCTION ELECTRIC RAILWAY SYSTEM.

There is no evidence that existing methods of street railway practice will be abandoned, especially those employing the overhead construction, as it will always have a place on account of its simplicity even after the most revolutionary invention appears. But it has its disadvantages when used upon the principal streets of cities and towns. The question, then, is: What kind of an electric system is waited for and required for cities and what will be its advantages. One answer would seem to be: First, a system that will receive its power directly from a power station without the use of exposed or bare line conductors; second, a system without a slotted conduit; third, a system that will allow a high voltage to be used without danger; fourth, a system that will not require batteries on the cars.

An electric system claimed to have the desired advantages has been devised by Mr. M. W. Dewey, of Syracuse, N. Y., and will now be briefly but clearly described. The principle upon which this system is founded is that of induction, that is, the current used on the car to propel it can be induced by, and be entirely separate from the current generated at the power station and transmitted along the line of travel by the line conductor. In applying this method of induction, use is made of the fact that the presence of a complete or nearly complete magnetic circuit in or around the primary and secondary electric circuits greatly increases the inductive effects of the primary current. The means by which this method may be carried out consist in constructing the elements of a magnetic circuit or each of a number of such circuits in two parts, one of which is stationary, and embedded in the roadway, the other being carried by the car, Fig. 1. The stationary part is energized by a pulsatory or alternating current and the induced current is generated in one or more coils surrounding the movable part of the magnetic circuit. The movable part of the transformer on the car is continually in inductive relation to one or more of the stationary parts of the transformer.

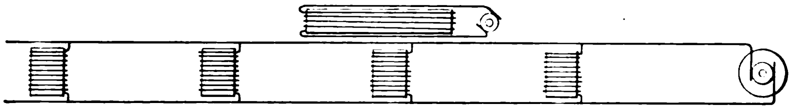


Fig. 1.

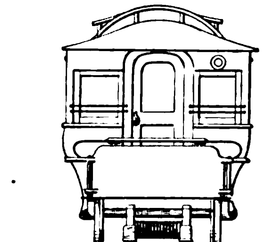


Fig. 3.

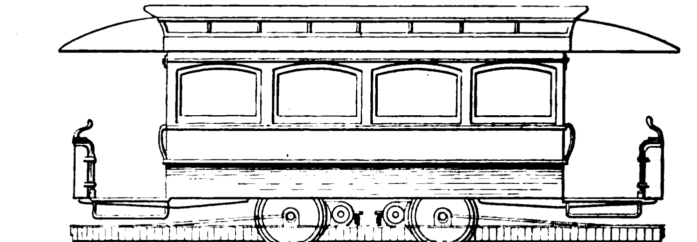


Fig. 2.

Figs. 1, 2 and 3.—Dewey's Induction Railway System.

The plan is to place coils upon U-shaped iron cores about the length of a car apart, in the roadbed between the rails, the ends of the core on a level with the pavement or slightly above it, and protected by roughened iron wearing plates, Figs. 2 and 3. The conductor extending to the coils is laid underground along the railway. The several cores and coils in the roadbed form one-half of the transformer apparatus, the other half of which is carried on the cars. Each motor has an inverted iron core upon which the secondary coils are wound. The ends of the vehicle core come above, and in proximity to, the ends of the roadbed cores. If a complete magnetic circuit is to be maintained by the cores, the vehicle core is made somewhat longer than the distances between the roadbed cores, and iron brushes or wheels are secured to the ends of the vehicle core to make contact with the stationary cores.

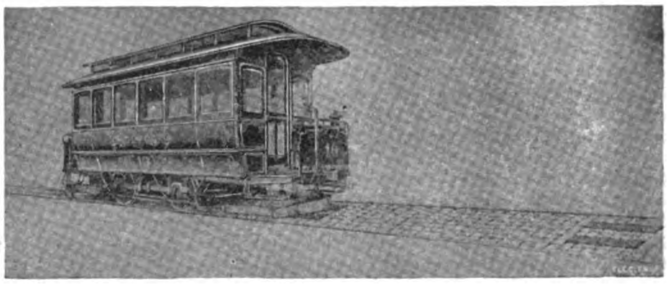


Fig. 4.—Dewey's Induction Railway System.

The first cost of construction of this system would be somewhat greater than that of the overhead, but is claimed by the inventor to be much less than a cable or slotted conduit road, and far less expensive to keep in working order. The entire road need not be equipped with this system unless desired, but only the part passing through the principal streets, the rest being equipped with the overhead construction which can be made to work well and in harmony with the proposed system, of which the accompanying illustration Fig. 4 will insure a clear understanding.

ALUMINUM LIGHT.

Finely divided aluminum has previously been suggested as a substitute for magnesium as an actinic light for photographic purposes. Now that it is cheaper than magnesium, the following formula for a mixture, which is recommended by a French contemporary as giving a powerful flash, may be of use to those interested in photography—100 parts aluminum powder, 25 parts lycopodium, 5 parts ammonium nitrate. This powder can be used for flashing in an ordinary spirit lamp, but gives a brighter and more powerful light if the powder be flashed into the flame by means of a jet of oxygen gas.

The Cleveland, Ohio, Electric Club is in a thriving condition. It meets on the first and third Wednesdays of each month, and has already fifty members.

CARBON ACCUMULATORS.

BY

Jas. A. Lounsbury.

In an article published in a recent number of The Electrical Engineer, Prof. W. M. Stines gives the results of some experiments with accumulators having carbon electrodes, in which the secondary current was produced by the reunion of oxygen and hydrogen gases previously formed by the decomposition of water. A few words in this connection regarding some facts which came under the writer's notice about three years ago, may be of interest. The experiments were not very complete and the data obtained is of little value except in a general way, as facilities for making accurate measurements were lacking.

While using, in the regulating circuit of an arc dynamo, a resistance composed of two arc lamp carbons immersed in a weak solution of sulphuric acid, the writer found that the positive electrode was badly corroded after a current of about five amperes had been passed through the solution for a short time, and that the negative carbon had increased in size. This increase however, was not equal to the decrease in size of the positive electrode, for a considerable amount of carbon remained in suspension in the liquid.

Thinking that where there was an action of this character, a reaction might be looked for, and the wires from the dynamo were disconnected and the carbons connected together through a galvanometer. A large deflection of the needle resulted. Afterward a large cell was made with plates composed of a number of lamp carbons, this being the only form of carbon available at the time. In this battery the total area of the plates was about 400 square inches. After charging with a current of twelve amperes for about an hour, the cell was short-circuited through an amperemeter, and a secondary current of about nine amperes was obtained. This rate of discharge was maintained only for a few minutes, however, the current gradually dropping to about four amperes, where it remained fairly constant for a while, and then dropped slowly to zero. As a low reading voltmeter was not at hand, no tests to ascertain the voltage developed were made. It is probable that the gas generated by a charge of twelve amperes for an hour, was considerably in excess of the storage capacity of the plates, and that as large an output would have been obtained with a smaller charge.

In the first cell carbon was transferred from the positive to the negative electrode, but in the larger cell this deposition of carbon was not noticeable, though the positive plates showed signs of corrosion, and considerable carbon remained in suspension in the liquid, as before. The reason that this transfer of carbon was not as noticeable in the second case, was probably due to the fact that while the charging current was doubled, the surface area of the plates had been increased about 30 times. It is probable that for a given area of electrode surface, the amount of carbon deposited would increase, and the amount held in suspension decrease with the *rate* of charge. The same instability of charge mentioned by Prof. Stines was noted; a full charge disappearing completely in ten or twelve hours with battery on open circuit. This was supposed to be owing to the escape of the gases into the air. This escape of gas might have been prevented in a large degree, by the use of an electrolyte in the nature of a paste. One peculiar feature noticed was that after short-circuiting the battery until the voltage had fallen to about one-half the original, if the short-circuit was broken and the cell allowed to stand for a short time, it would regain its original strength, acting in this respect similar to an over worked primary battery.

This subject of carbon secondary batteries is a fascinating one, and could they be made practicable, the storage battery would again return to the high position in the regard of the public which it has occupied periodically for the past eight years. Accumulators of this kind would be very cheap to manufacture and maintain. The absence of all active material, so called, would be a great advance over the present method of manufacture. The efficiency is very good, though it is doubtful if the *weight* efficiency is much higher than that of the lead type.

Prof. Stines' form of cell has the great advantage over that employed by the writer in that he obtained a very large storage capacity for the gases by the use of finely divided carbon, with a great reduction in bulk. The reversibility of a carbon accumulator would be a great point in its favor. In charging, the negative plate which had "grown" could be made the positive, and so become the one subject to disintegration and the plate, positive in the previous charge, and therefore corroded, would be built up. It is probable that the number of times this reversal could be made would be limited, as the amount of carbon taken from the positive plate each time would not be deposited on the negative, a portion being added to that already in suspension in the liquid.

THE FIVE-WIRE ELECTRIC LIGHT STATION AT TRIENT, AUSTRIA.

As most of the electric light stations in the United States which are operated by water-power are so planned that the generators are located near the water-power, the following abstract of a recent lecture before the Austrian Society of Engineers and Architects, by Herr Hugo Koestler, will prove interesting, as it describes a plant in which the dynamo station is located near the town and the water is carried to it under considerable pressure for quite a long distance from the dam. The town of Trient, in Southern Tyrol, population about 23,000, has always been subjected to more or less danger from a neighboring stream, which threatened during high water to flood the adjoining land. Several dams were built from time to time to regulate this stream and finally, in 1884, the municipal authorities built a dam about a mile away from the town, which afforded a fine water-power.

This power they determined to use for generating electricity, but instead of locating their station at this point, where a fall of some 170 feet was available, they constructed a canal, principally in tunnel, 0.47 mile long, 3.28 feet wide and 2.95 feet high. Unfortunately the speaker did not state how this tunnel was driven, which was a serious omission, since the cross-section is so small that the engineering details of the work would be interesting. This canal empties into a reservoir, containing about 90,000 gallons, which serves as a regulator to maintain a fairly uniform pressure at the turbines, about 2,000 feet distant and 289 feet lower. The reservoir and turbines are connected by two cast-iron mains 25.6 inches in diameter, uniting at the power station into a single main 35.43 inches in diameter.

The generating station is about 3,400 feet from the centre of the town and contains 6 Girard turbines; each furnishing 140 actual horse power at 265 revolutions. Six direct-coupled dynamos are used, each giving 160 amperes at 550 volts, so that the station has a maximum capacity of 960 amperes. The distributing system is arranged on the five-wire plan, and is underground except in the outskirts of the town. The "outer" conductors have a difference of potential of 440 volts, which is divided by the three "inner" conductors into fields of 110 volts each. Two arc lights are used in one field or group, four on alternate conductors or eight when the outside wires are connected. The incandescent lamps are wired in small groups with an E. M. F. of 110 volts, while the connections of the electric motors are made to give 110, 330 or 440 volts as desired.

A secondary battery has been set up in the generating station and is charged during the hours of highest consumption. Its capacity is such that in case of accident to the water mains or driving machinery, it could supply nearly the maximum current required for public and private purposes for about an hour. The plant was designed by Chief Engineer Appollonio and his assistant, Herr Foyorelli, the latter being in charge of the station at present. The turbines were furnished by the Machinery Works at Vevey, Switzerland, and the electrical apparatus by the Vienna branch of Siemens & Halske.

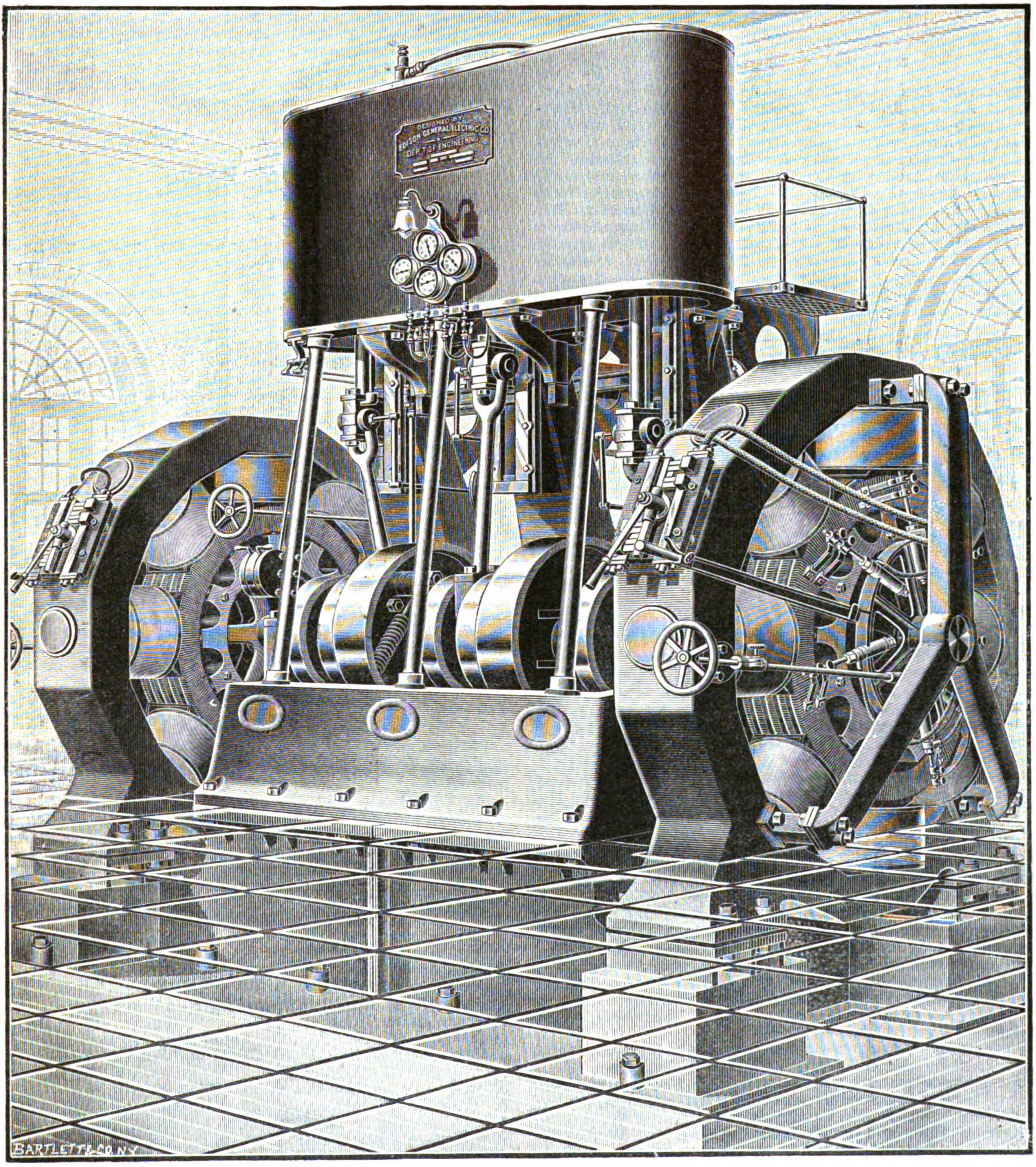
The entire plant, including land damages, canal, mains, buildings, turbines, electrical apparatus, wiring and lamps, but exclusive of the dam, which was not built for power purposes originally, cost about $233,400. The public lights supplied from the station embrace 560 incandescent lamps of from 16 to 35 c. p. and 28 9 ampere arc lamps. The private consumers had about 6,000 incandescent and 30 arc lamps in use at the beginning of the current year, and also took something over 200 h. p. for motors of from $\frac{1}{16}$ to 50 effective horse power.

NOTE ON ROTARY CURRENTS.

At a recent meeting of the London Physical Society, says our London correspondent, a note was presented on the above subject. Alternate currents could be obtained from an ordinary direct-current dynamo by making contact with two points in the armature, say by connecting these points to insulated rings on the shafts, and using extra brushes. A direct-current motor, similarly treated, transforms direct currents into alternating currents, or into mechanical power. If two pairs of points in the armature be selected, situated at opposite ends of two perpendicular diameters, then two alternating currents, differing in phase by 90 degrees can be obtained; and by choosing suitable points in the armature, two, three or more currents differing in phase by any desired angles can be produced. In ordinary motors the connections for doing this would be troublesome, but the Ayrton and Perry form, which has a stationary armature, lends itself readily to this purpose, for contact can be made with any part of the armature with great facility. A motor of this kind was exhibited, in which contact was made with four equidistant points on the armature. On connecting opposite points through fine platinum wires, and running the motor slowly, the wires glowed alternately, one being bright, while the other was dark, and *vice versa*, thus demonstrating the existence of two currents in quadrature. When the four points on the armature were joined to the four corners of a square of platinum wire, the wires became incandescent in succession, the glow appearing to travel round the square, and suggesting the idea of the rotary currents.

EDISON MULTIPOLAR GENERATORS AND TRIPLE-EXPANSION ENGINES.

In our issue of January 17, we illustrated and described the Edison multipolar generators, geared directly to the shaft of a triple-expansion engine. The cut illustrates further details of construction, and shows the condensing box and foundation of the engine. The engine is of the triple compound three-crank inverted cylinder, automatic condensing type, well proportioned throughout, having large wearing surfaces which can be easily adjusted. The bedplate to which the main bearing boxes of the crank shaft are cast is strong and is firmly bolted to a massive foundation box which also carries the dynamo frames—thus perfect rigidity between engine and generators is ensured. The crank shaft is of forged steel, fitted with cast-iron balance discs to which the crank pins are fitted. There are two bearings to each crank and an additional large bearing on each end of the shaft to carry the armature. On the shaft are three eccentrics, each operated by its own independent governor, so that the point of cut-off in each cylinder is changed equally with the load, thus doing away with any tendency to race, in case the total load is at any time thrown off or any accident happen. Strong cast-iron columns carry the cylinders which are bolted together, and the engine is strong, compact and well arranged; indeed, these engines are almost fac-similes of the latest and most improved types at present in use on the finest ocean steamships, with necessary additions to render them as highly efficient for electric generating purposes as their prototypes are for marine work. They are calculated for the maximum efficiency point at about 12½ per cent. below the normal maximum capacity of the generator, and have a range to a maximum capacity of 20 per cent. above the normal maximum output of the generator at 160 pounds initial



Edison Multipolar Generator and Triple-Expansion Engine.

pressure and a vacuum of 24 inches, thus allowing each engine, in case of accident to the condensing apparatus, to operate the generator satisfactorily non-condensing. In addition to the many advantages already mentioned these engines when connected to a suitable condenser, will, it is claimed, reduce the consumption of fuel considerably. This is an item of importance in electric light stations, increasing their storage, boiler and engine capacity.

Obituary.

MR. ANDREW B. ULINE.

INFORMATION has arrived here of the death at Nassau, N. P., of Andrew B. Uline, general manager of the Hudson River Telephone Company. Mr. Uline was born in West Sand Lake, Rensselaer County, on July 17, 1836. He was educated at the district school and then went to Indianapolis. In 1868 he went to Albany as agent for the Merchants' Despatch. In 1878 he formed the Commercial Telephone Co., which was subsequently merged with the Hudson River Telephone Co. Mr. Uline was a Democrat and had held the place of Fire Commissioner since 1886. He was a man of warm friendships, and was greatly liked in electrical circles, especially in New York City, where he was a frequent visitor. We understand that Mr. W. D. Sargent, vice-president of the New York and New Jersey Telephone Co., was in Nassau with Mr. Uline.

MR. ANDREW IRVINE.

WE regret to announce the death of Mr. Andrew Irvine, a Western agent of the National Electric Co. of Eau Claire, Wis. We are in receipt of a copy of the special resolutions on his death, adopted by the City of Pekin Electric Light and Power Co. of Pekin, Ill., in which they speak in the highest terms of his ability and character, as evinced in his recent business relations with them,

Literature.

Electric Light Cables and the Distribution of Electricity. By Stuart A. Russell. *New York:* Macmillan & Co., 1892. 311 pp. 5 x 7½ inches. Price, $2.25.

As the title indicates, the subject treated of in this volume is limited to that branch of electrical engineering which relates directly to the properties of conductors and their effective adaptation to the requirements of the various systems of distributing electrical energy for various purposes. That this portion of the applied science has now become of such magnitude and importance as to merit specialization can hardly be disputed, and indeed the French seem to have found it necessary to distinguish by the word *canalization*, that part of a system of distribution that relates only to those trunk conductors, which transmit the energy produced by the generating plant to the extremities of the network of conductors embodying the translating devices.

The book discusses the relative advantages of various conductors and the results most favorable to copper. The important question of the most economical employment of this costly but necessary element of distribution is deduced from the law which was pointed out by Lord Kelvin, and the results of Prof. Forbes' practical experiments. Then follows an inquiry into the effect of rise of temperature on copper conductors, based on the excellent data on the heating of bare and insulated copper wires under different conditions of exposure and protection, derived from Mr. Kennelly's very valuable experiments.

The difference of the resistance of conductors carrying alternating currents is also considered, and the determination of the *virtual* resistance of such conductors exemplified by the convenient table of virtual resistances of different conductors calculated some time since by Mr. Mordey from the figures supplied by Lord Kelvin. Rules and calculations relating to loss of pressure, heating, etc., in their relation to the size of the conductor derived from these modern conceptions and experimental evidence of underlying principles, are presented and on the whole provide a comprehensive résumé of the subject.

Various systems of distribution are critically examined in a manner to be commended,—series, parallel, feeder and multiple systems, besides accumulator, motor-generator transformer and periodic current transformer systems being described. The offsets and disadvantages of multiple systems of more than three wires, and the limitations of accumulator-motor-generator transformer systems like the Chelsea central and sub-station supply, and of series systems like Bernstein's transformer system, are unhesitatingly exposed.

As would naturally be expected, the book describes and illustrates many industrial types of wires for aerial lines and interior installation, cables and conduits for aerial, underground and under-water mains, among them interesting systems in actual use, including the Ferranti mains and Edison tubes. Much practical matter has been incorporated relating to the construction of overhead and underground lines, including detail apparatus, protector instruments, together with data relating to strains on aerial cables supported by bearer wires.

Mr. Russell wisely insists on the importance of systematically testing the conductors of electrical distributing systems, and besides useful hints regarding the same gives methods of making mechanical and electrical tests, including the testing of cables during laying and jointing. On the whole the volume may be credited with embracing the subjects indicated by its unassuming title in a satisfactory manner, and the book will undoubtedly prove useful to constructing engineers.

G. B. P., JR.

Legal Notes.

LANE-FOX vs. KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHT CO.—ON STORAGE BATTERY CENTRAL STATIONS.

A VERY elaborate judgment was delivered on March 20 by Mr. Justice A. L. Smith in Chancery Court in the suit of Lane-Fox *vs.* Kensington and Knightsbridge Electric Light Co. for infringement of patent issued in 1878 to the former. On the part of the defendants it was claimed that the patent was void, owing to the discrepancy between the complete and provisional specifications; further, that the patent was not drawn up in such a way that it was intelligible to an ordinary mechanic without further instructions.

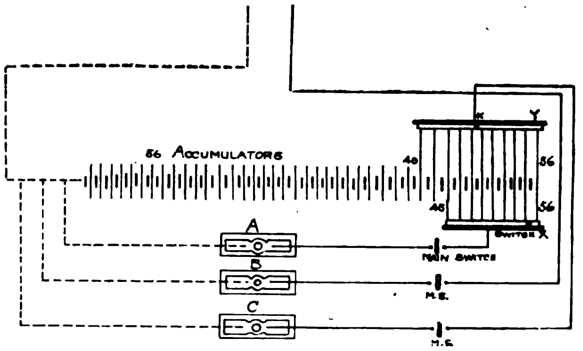


DIAGRAM IN THE LANE-FOX LITIGATION.

In Lane-Fox's final specification it was claimed that "the secondary batteries were to act as reservoir batteries to keep the potential in the mains constant," and for this a means of regulation was specified in the provisional, but omitted in the final specification. Mr. Lane-Fox had come to the conclusion that the special means of regulation was not necessary, as the batteries themselves acted as regulators. This discrepancy was fatal to the suit and the patent was declared invalid.

It need hardly be stated here that secondary batteries require very elaborate regulating switches. Expert opinion was called by both sides, among the witnesses for the plaintiff being Professors S. P. Thompson, John Perry and George Forbes, while for the defendants, among others, Sir Fred. Bramwell, R. E. Crompton, Dr. John Hopkinson and J. Swinburne were called. One of the claims of Lane-Fox, the use of the earth return, was early disallowed in the case, as the Judge had become fully convinced that its use was not practicable. The evidence upon the definition of what was implied was very conflicting; only two cases could be cited in which storage batteries were used and where no further regulating switches were employed. Further, in each case the installation was only small. On this point, too, the Judge decided that regulating switches or devices were necessary for the practical operation of the batteries.

For the defense a model was produced showing the various combinations which could be accomplished by means of the regulating switches at present installed by the defendant company in their two stations situated in Kensington Court and Knightsbridge. A diagram is here given which will readily explain itself. As evidence of the necessity of using regulating devices, the first plan which was installed in the Royal Courts of Justice was instanced. In this case the batteries were ordered to be removed from the building, owing to the lack of regulation, within a few days of being installed. Curves of charge and discharge were freely referred to, showing the rapid rise in potential of the cell just before the boiling point is reached, and much stress was also laid on the rapid fall of potential at the commencement of the discharge with the subsequent prolonged gradual decrease which takes place, until a point is reached, just before the almost total discharge of the cell, where the potential takes another sudden and rapid drop.

It is worthy of mention that, so far as can be recalled, no mention was made by any witness of the use of an automatic break switch. No installation would be complete without one for cutting out the batteries from the charging circuit in case of accidental shutting down of dynamos or other cause. Apart from the discrepancy in the provisional and complete specification the patent was declared not to be sufficiently explicit to allow of an ordinary workman being able to use it without further instructions.

Very eminent counsel were engaged on each side; for the plaintiff, the Attorney General (Sir Richard Webster), Mr. J. Fletcher-Moulton, Q. C., and Mr. Wallace; while for the defendant company, Sir Horace Davy, Q. C., Mr. Finlay and a junior appeared.

JUDGE COXE'S DECISION ON THE PERFORATED STORAGE BATTERY PLATE.

WE are in receipt of the following communication from Mr. Wm. Bracken, president of the Consolidated Electric Storage Co. the exclusive licensees of the Brush storage battery patents:

The newspapers have in the last few days been made the vehicle for conveying to the public the idea that Judge Coxe of the United States Circuit Court for the Southern District of New York had in the case of the Accumulator Company against the New York and Harlem Railroad Company, awarded to one J. W. Swan, and his assignees, the sole and exclusive right to a perforated support plate for storage batteries; that without such a plate as Swan claims no practical storage battery had ever been made, and that this decision postpones indefinitely the use of storage battery cars and the like. We cannot better show how misleading these statements are than to quote from the decision itself. Judge Coxe says:

"The original patent, No. 312,599, dated February 17, 1885, was considered by this court in the case of the Accumulator Co. *vs.* Julien Co., 38 Fed. Rep., 117. The original was held invalid (page 140–142) for the reason that it described and claimed a plate the outer surface of which might be covered by the active material. This construction, in view of the work done by Prof. Eaton was held to be anticipated.

"The theory of the reissue is that the valuable feature contributed by Swan consists in confining the active material in the holes without permitting it to extend beyond them to the surface of the plate. That portion of the original which refers to the coating of the outer surface of the plate has been omitted in the reissue. In other respects the description is unchanged.

The claim is as follows:

> A perforated or cellular plate for secondary batteries, having the perforations or cells extending through the plate and the active material or material to become active packed in the said perforations or cells only, substantially as described.

"This is the claim of the original, except that the word, only, has been added.

"The patent cannot be criticised as a reissue. The claim instead of being broadened is greatly restricted. The application was filed within a reasonable time after the inventor was informed of the facts which made a narrower claim necessary. The facts bring the case within the provisions of section 4,919 of the Revised Statutes.

"The field of invention is, conceded, a narrow one. The counsel for the defendant correctly states that Swan's improvement consists wholly in the idea of putting on the surface of a perforated plate secondary battery, no active material beyond the contents of the perforations; everything except this is conceded to be old."

The date, *de jure*, of Swan's invention is January 18, 1882. Prior to that time Prof. Eaton had filled the perforations, but he had covered both sides of his plate as well. Mr. Brush had rammed or pressed absorptive substances, in the form of dry powder, into grooves or receptacles without covering the surface of the plate. No one had packed active material into holes extending through the plate, confining it entirely to these holes. The combination was original with Swan. Swan was not the inventor of the perforated plate. On the contrary, Judge Coxe took that claim away from him, in the case of the Electrical Accumulator Company *vs.* The Brush Electric Company. Neither has Swan the right to put the active material in the perforations or apply it in any way to a perforated plate, for that has been awarded to Brush.

Swan's claim is the narrow one of putting the active material in the perforations only. His claim does not cover the method of putting the active material in the perforations and at the same time spreading it over the surface of the plate. Neither does it cover the putting of the active material in any manner in grooves, receptacles or perforations that do not extend wholly through the plate. In fact the claim is as narrow as it is of doubtful utility. The progress of the storage battery industry will not be retarded one hour by the decision.

THE ACCUMULATOR COMPANY vs. N. Y. & HARLEM R. R. CO.—A DECISION ON STORAGE BATTERY GRIDS.

THE following is an abstract of the opinion of Judge Coxe in the case of the *Accumulator Company* vs. *N. Y. & Harlem R. R. Co.*, of April 9, 1892, referred to in these columns last week:

This in an action alleging infringement of patent No. 11047, reissued to complainant as assignee of Joseph Wilson Swan. The invention consists in forming the electrodes of secondary batteries with perforations extending through the plates, in which the active material is packed. The original patent was held invalid by this court in the case of *Electrical Accumulator Company* vs. *Julien Company.* (The decision rendered by Judge Coxe, March 18, 1891), upon the ground of having described and claimed plates, the outer surfaces of which were covered with active material, which in view of work previously done by Prof. Eaton, was held to have been anticipated. The theory of the reissued patent is that the valuable feature of Swan's invention consists in confining the active material to the holes, not permitting it to extend to the surface of the plate. The claim of the reissued patent is as follows:

> A perforated or cellular plate for secondary batteries, having the perforations or cells extending through the plate, and the active material or material to become active packed in said perforations or cells only, substantially as described.

The reissue has not broadened, but on the contrary has greatly restricted the claim, and the application was filed within a reasonable time after the inventor had become aware that such restriction was necessary. Swan's date, *de jure*, is January 18, 1882. Prior to this, Eaton had filled perforations and covered both sides of the plate with active material, and Brush had pressed the absorptive material into grooves. No one had packed it into holes extending through the plate, and confined it entirely to the holes. Did it involve invention to do this? It is necessary to remember that we are dealing with a new and abstruse art, where most important results may follow from changes apparently of the most unimportant character. In holding that there is a sufficiency of invention to support the patent, the court has been influenced by the consideration that Swan's electrode is today the electrode of commerce, having largely supplanted all others and being in almost universal use. The advantage of having the active material in small disconnected masses, packed in holes extending through the plate, seems unquestionable. The electrolyte is permitted to reach and act upon both sides of the small masses instead of one side only. Defects which produce buckling and short-circuiting and other disastrous results are entirely remedied by Swan's construction. The step from the electrode of Eaton and Brush to that of Swan seems very short, but standing where these men did, and looking forward to the ideal electrode, avoiding all the difficulties then existing, the steps undoubtedly seemed many and long. If Eaton had scraped the active material from his plates, leaving the holes full, he would have had the invention, but he did not. If Brush had punched out the bottom of his receptacles and had then rammed them full of active material, he would have made a successful structure, but he did not.

As to the infringement, there can be no doubt. The question as to the effect of the expiration of the Danish patent has not been argued, but casual examination has led to the conclusion that it is not for the same invention as Swan's reissued patent. Decree for complainant.

Letters to the Editor.

INSURANCE OF CENTRAL STATIONS.

I AM much interested in your editorial on page 356, of your issue of April 6, concerning insurance of central stations, and the tactics adopted by one central station manager to get his rate reduced, as stated in his communication to you. His method is not new at all; in fact it was tried and worked successfully in hundreds of cases during the two years' life of the Electric Mutual. If it had not been resorted to so generally, and on the other hand, if the insurance of central stations had been given to the Electric Mutual at its low rates instead of using it to beat down the rates of local boards with, the Mutual would have been a strong institution in existence to-day. I fear that although the plan worked so well in the case mentioned, it will not generally work, because the New England mutuals are almost entirely withdrawing from central station risks since the retirement of the Electric Mutual, in which they placed their faith for the selection and care of the risks; and insurance boards are generally "onto" the fact that the mutuals have stopped. In the Southeastern States rates have been advanced, and a movement is on foot for a similar advance in New England, the home of the mutuals, which were used so successfully to pull the chestnuts out.

I hope I am mistaken, but I fear that the great mistake was that the central station men did not fully appreciate the value to them of the Electric Mutual and its allies Time will tell.

I must take exception to the inference that may be drawn from your correspondent's statement that he ran any risk with the mutual companies he had. They were among the best and as solvent and sound as any companies doing business. Since the expiration of their policies on the station in question, the dividends earned have doubtless been paid and after deducting them from the 80-cent rate paid, I wonder if the present rate is "even better." I make the above comments because it is the first time I have seen in print an acknowledgment of the real uses to which the Electric Mutual was so frequently put. It may prove another case of the goose and the golden egg, and if the signs of the times are right it may demonstrate afresh that one cannot have his cake and eat it too.

Only three months ago the Mutual stopped. A great many central station men regret it already.

STEPHEN E. BARTON.

NEW YORK, April 12, 1892.

POTENTIALS AT 500,000 VOLTS.

IN common with many others I have read with much interest Prof. Elihu Thomson's paper on "Dynamic Induction at High Potential and Frequencies" in your issue of March 30, 1892, and as further demonstrating the high insulating qualities of oil and as making us familiar with a very convenient and easily constructed apparatus for obtaining high potentials the paper is of very great interest—but the paper also contains what I believe to be a serious error. Prof. Thomson says he easily obtained sparks of over 31 inches and "so far as can be estimated from available data these sparks were due to potentials of not less than half a million volts."

This of course is a cautious statement, and yet must convey the idea that he thinks such potentials are possible in air at ordinary distances; but in view of the experiments of Mascart and others on striking distances it would seem that it were simply an impossibility to obtain such potentials as 500,000 volts in air, as probably any length of air at ordinary temperature and pressure would break down under a much less electrical stress than 500,000 volts. Referring to the table of results given by Mascart in his second volume of his "Traité d' Electricité Statique," it is seen that for distances not exceeding about 2 cm., between balls 22 mm. in diam. the difference of potential is approximately proportional to the striking distances—and beyond that point the difference of potential increases slowly; at 10 cm., the difference of potential is 119,100 volts while at 15 cm., or 50 per cent. greater, the difference of potential is only 127,800 volts—that is, with an increase in sparking distance of 50 per cent., the voltage necessary is only about 7 per cent. greater. Plotting from Mascart's results a curve whose ordinates are potential differences and whose abcissæ are striking distances, we have a curve which might be called the electric strain diagram of air and shows that the difference of potential in air tends to a limit probably not greater than 150,000 volts and this potential would be capable of sparking any distance, from several inches to possibly many miles.

It may be argued that as Mascart only used a maximum striking distance of 15 cm., nothing can be inferred from his results, as to the potential differences at greater sparking distances, but I think the shape of the curve as far as plotted and our general knowledge of the nature of electrical stresses will allow us to infer with accuracy the shape of the curve up to several feet at least, when it is seen that Prof. Thomson was using probably not over one-third the voltage he suggested. In the light of these experiments of Mascart and others, it is evidently absurd to talk of transmitting electrical energy at two or three million volts on bare wire in air, as such pressures would probably be sufficiently great to spark quite around the earth, but higher pressures than can be used in air might however be used by surrounding the conductor by a material such as oil, having a greater dielectric power than air, as suggested by Prof. Thomson in THE ELECTRICAL ENGINEER of March 23. R. B. OWENS.

DEPARTMENT OF ELECTRICITY,
UNIVERSITY OF NEBRASKA,
April 12, 1892.

Society and Club Notes.

THE BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.

THE wonderful development of the electrical industries during the last decade is nowhere better illustrated than in the gratifying growth and prosperity of the Institution of Electrical Engineers of Great Britain. Founded in 1871, as the Society of Telegraph Engineers, with a membership of 110, its first meeting was held on February 28, 1872, under the presidency of the late Sir Charles W. Siemens. In his inaugural address, the president said that London, being the principal centre of the telegraphic enterprise of the world, was unquestionably the proper seat of such a society, observing at the same time, that the manufacture of submarine cables was almost entirely confined to the banks of the Thames, a circumstance which still remains true after the lapse of 20 years. Mr. Latimer Clark made the following prophetic remarks:

> I feel assured that this society will grow and increase, and that it will ultimately become a large and important institution. If you read the scientific works and periodicals of the day, you cannot fail to perceive that electricity, magnetism and electric telegraphy occupy a large and increasing share of public interest and attention. I hope, therefore, that this society will develop into something more than a mere telegraph society, and that it will gather into the compass of its proceedings a large share of the many valuable and interesting papers which we now see read before other societies, and scattered among other scientific publications. When that time arrives, and not till then, I shall feel that the Society of Telegraph Engineers has assumed its proper function and position in the scientific world.

Within 10 years from the date of organization of the society the prediction of Mr. Clark had been more than fulfilled. The field of the society's labors had not only immensely broadened in its scope, but had extended itself into many new and hitherto unexplored regions of science. In 1889 the name of the society was changed to that of "The Institution of Electrical Engineers," a somewhat unfortunate choice, by reason of its almost exact identity with that of the distinctive title of the sister society in the United States, which was organized in 1884.

The Institution now numbers 535 full members, 1,079 associate, 2 honorary, and 177 foreign members, besides 183 students; a total of 1,976. The list of foreign members in the United States numbers 36, the senior member being Franklin L. Pope, who was elected in 1872. Among the distinguished men who have occupied the presidential chair of the society may be found such names as Sir Frederick Abel, Latimer Clark, Prof. William Crookes, Dr. John Hopkinson, Prof. David E. Hughes, Lord Kelvin, better known as Sir William Thomson, William H. Preece, Sir Charles Siemens, Cromwell F. Varley and many others. The transactions of the society have been issued regularly since 1872, and now number 21 volumes, while the membership extends to almost every country on the globe.

CHICAGO ELECTRICAL ASSOCIATION.

PROF. C. S. COOK, of Evanston, favored the Chicago Electrical Association at its regular meeting April 12th, with a review of Dr. Hertz's researches on electromagnetic waves. These experiments are now familiar to electrical students, and their bearing on both theory and practice is coming to be better understood. Prof. Cook showed how Hertz's work was the fulfilment of Maxwell's speculative theory and how it revealed the close relations between the forms of radiant energy known as light and magnetism.

Following the order in which Dr. Hertz made his varied experiments, from the earlier ones on determining the length of electromagnetic wave lengths to the more recent ones which tend to show the depth to which alternating currents penetrate conductors, the lecturer showed the bearing of these points on our present ideas regarding the transmission of electrical energy. A brief discussion closed the evening's progamme. At the next meeting, April 26th, Mr. F. R. McBerty will read a paper on the "Sparking of Dynamos."

Personal.

MR. J. DOUGLAS DALLAS has established himself as an electrical engineer and electrician at room 511, Mansion House Chambers, London, England. He is well known in this country, where he spent five years in professional work. He was at one time with the Edison General Co. at Schenectady and later with the Railway Department of the Thomson-Houston Co. as an expert. He also had considerable experience with storage batteries.

MR. A. HYDE, who a few months since was placed in charge of the underground cables of the Minneapolis Brush Electric Co., has now been appointed superintendent of the company. The company's plant is now in excellent condition, most of the circuits being underground and working well.

MR. JOHN W. CHERRY, who has been the manager of the Toledo telephone exchange, is removing to Indianapolis to assume his duties as general manager of the exchange in the latter city.

MR. HUNT MAY EARN HIS LIVING.

JUDGE TRUAX, in the N. Y. Supreme Court has dissolved the injunction obtained by default by the W. J. Johnston Co. against W. T. Hunt and the Electrical Age Publishing Co.

This was an action brought by the W. J. Johnston Co. to restrain W. T. Hunt from soliciting advertising for the *Electrical Age*, and the Electrical Age Publishing Co. from employing Hunt.

This case has attracted considerable attention in electrical circles throughout the country.

TRADE NOTES AND NOVELTIES

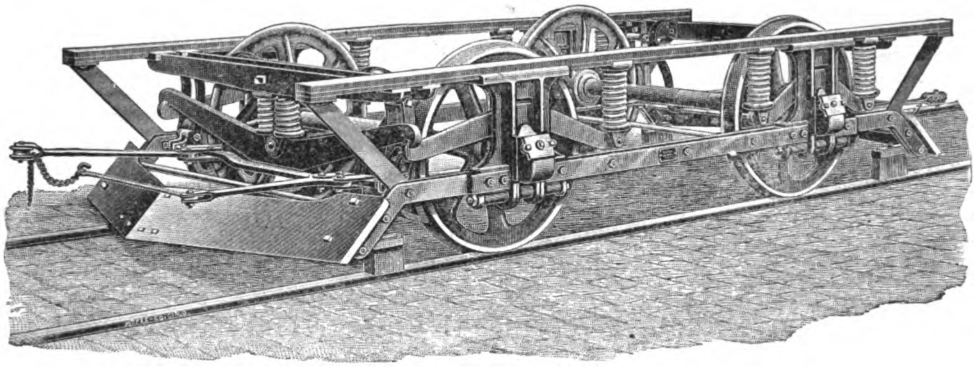
AND MECHANICAL DEPARTMENT.

Know your public, and let the public know you.

THREE RIVERS NEW EQUALIZING MOTOR TRUCK.

In no portion of electric street railway work have greater improvements been made than in the trucks, which, with the advent of the electric motor, demanded many material changes in construction. The latest development in this line is the new equalizing truck for electrical work, manufactured by the Sheffield Velocipede Car Co., of Three Rivers, Mich., which, on account of its novel features and improvements, is attracting considerable attention in street railway circles. The accompanying illustration shows very clearly the principal features of the device, the leading one of which is the simple and effective mechanism for equalization of strains. This principle is considered by street railway men to be of the greatest importance and has been very cleverly carried out by the Sheffield Velocipede Car Co. who enjoy a high reputation for their other specialties in steam railroading and other lines.

One end of the car is carried upon side equalizing bars, long coiled springs being introduced between the truck and the car body, giving exceptionally easy results in riding. The other end of the truck is carried by means of similar side equalizing bars, one end of these bars being cushioned against the main side sill of the car, the other end engaging with a cross-equalizer, attached similarly to the other side, and being cushioned against suitable carrying bars in the centre. The result of this is, as claimed by the manufacturers, a practical three-point suspension for the car body on one end of the truck, the car being supported over each of the wheels, whereas the support on the other end, by means of the cross-equalizer, is carried to the centre of the car. By this means all twisting strains are avoided, and the shocks and jars incident to rapid speed and severe service are very largely absorbed and neutralized.



Three Rivers Equalizing Motor Truck.

The construction is such that the two ends of the truck play freely in a vertical plane without imparting disagreeable oscillation to the car body, and also give greater ease in the matter of curves and uneven track. The wheels of these trucks are ground to an exact match in circumference, after being pressed on the axles, thus insuring not only the perfect pairing of the wheels, but that they shall run with absolute truth with reference to each other.

The bearings, which are all of heavy gun metal, are carefully milled to fit the axles. The boxes are made self-oiling, and will run for a long time without attention. The brakes are arranged in an entirely new plan, giving very much greater power than has heretofore been secured for this purpose and applying it equally to each wheel. The brake shoes are of an improved form, and can be replaced when worn by the removal of a single key, with but the loss of a moment's time. The removal of wheels when worn is accomplished by the taking out of a single heavy bolt on either side, a point that will commend itself to many.

Another feature which should not be overlooked, lies in the fact that the whole framework of the truck, being carried by springs, which are also introduced between the main frame and the motor support, greatly increased elasticity is secured for these parts over that afforded by other devices for this purpose. This very materially assists in relieving strain and lessening breakage of gears and other wearing parts.

The truck is so constructed that the centre is left entirely open for the attachment of the motor, which is very easily gotten at in case attention is necessary, as there is no complicated mechanism in the way. The truck is furnished, properly arranged, for any of the well-known systems of propulsion, and is in use on a number of prominent roads, results showing even more forcibly than had been expected, the great desirability of the special features of the device. A sample truck recently furnished to a large electrical street railway corporation resulted in an order for 20 more.

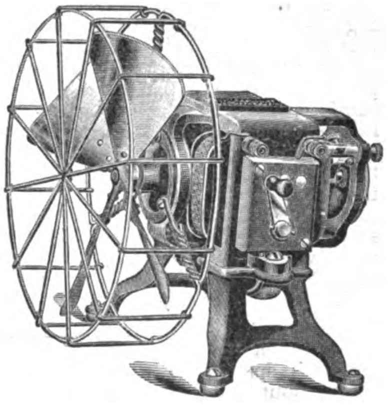
By the use of this truck it is claimed that not only are the electrical repairs very greatly reduced, but greater ease is secured to the passenger, and the life of the whole apparatus, as well as the permanent way, is greatly increased.

INTERNATIONAL TRADING AND ELECTRIC CO.

The International Trading and Electric Co., of the *Times* Building, this city is engaged actively in spite of political troubles in the South American Republics in pushing their goods in these markets. From all accounts their incandescent lamp, the "International," is making an excellent record. It is guaranteed for an average life of 1,000 lamp hours. The company act as agents for export for the Bishop Gutta-Percha Insulated Wire Co., the McCreary Electrical Mfg. Co., Queen & Co., and other high class manufacturers. The officers of the company are: Henry F. Herkner, president; U. T. Fackenthall, treasurer; and W. H. Fleming, who is well known among the electrical fraternity, is general manager.

THE RANDOLPH DAISY FAN MOTOR.

"The greatest economy in consumption of electric energy," is one of the claims of Mr. Randolph, of 425 The Rookery, Chicago, for his fan motor, the "Daisy," shown in the accompanying illustration. This little motor is wound for 110 volts and requires the same amount of current as one 16 c. p. lamp. It has three speeds, 900, 1,200 and 1,800 revolutions per minute. The bearings are very long, are made of lignum vitæ and require but little oil. The motor runs noiselessly and is attractive in appearance. Mr. Randolph is anxious to secure agents in every city to introduce the device.



Randolph Daisy Fan Motor.

NEW CONTRACTS FOR THE SHORT RAILWAY SYSTEM.

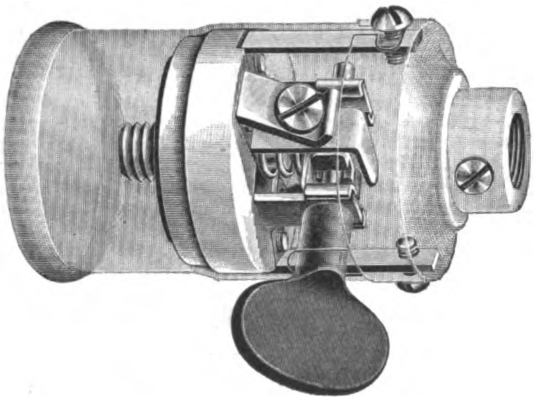
Mr. Edward J. Wessels, the special agent for the Short Electric Railway Co., has just returned from New England, where he has been very successful, his contracts being, we believe, the first secured by the company in New England. It is a very vigorous start, as the orders represent no fewer than 52 motors. The Norwich Street Railway Co. has given Mr. Wessels an order for fifteen 25 h. p. single-reduction motors, to be put into service as soon as possible, the entire road being changed to electricity. The line construction has already been done, and the road will take its power from the plant at Taftville. Mr. E. P. Shaw, Jr., is superintendent.

Mr. Wessels has also carried off the prize at New Haven, where he has sold nineteen single equipments of 25 h. p. single-reduction motors and seven double equipments of the same type, to the New Haven and West Haven Horse Railway Co. The order for the engines and generators has been placed with Westinghouse, Church, Kerr & Co., who will supply three of their large sized direct-connected engine and dynamo units. A third contract is with the Natick, Mass., Street Railway Co., who have decided to add to their rolling stock four 25 h. p. single-reduction Short motors as soon as possible.

The Hygeia Hotel, Old Point Comfort, is just installing a 60 h. p. Ball engine, this being the third furnished this hotel by the Ball Engine Co., Erie, Pa.

THE PERKINS ELECTRIC SWITCH MFG. CO.'S SOCKET.

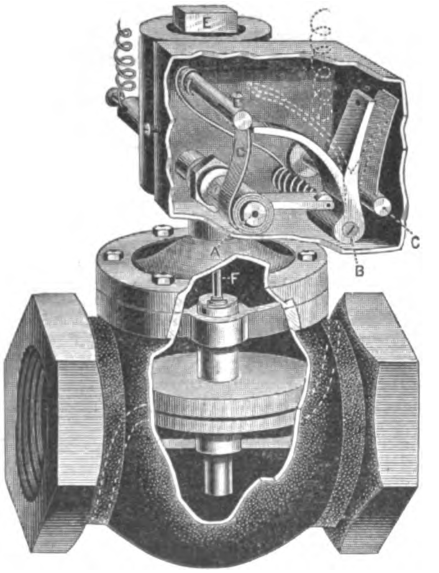
WE illustrate in the accompanying engraving a new socket manufactured by the Perkins Electric Switch Company, of Hartford, Conn. It will readily be seen that this socket possesses a number of novel features and admits of not a few important advantages. Differing from any other socket, there is only one porcelain, which is guided into the shell by two upright brass legs, which are thoroughly insulated from the contact pieces, the screws in the end of which hold the mechanism in the proper position in the shell. The cap is fitted on in the usual way, having a bayonet lock for the screw heads. As will be seen, the contact is made in a novel manner, by means of a parallel brass slide on two upright pieces of sheet brass, which form part of the one pole of the socket. This slide is always kept pressing up against tumbler by means of a small phosphor bronze spring, so that there is good contact at all times, the connection being made by means of the tumbler, when in a vertical position, between the slide and the L-shaped piece of brass shown in the engraving. It is claimed that this socket possesses all the best features of the existing sockets and is the result of careful development. The binding screws are well back from the shell. It is extremely easy to wire, and owing to there being only one porcelain admits of a large knot being made in the wire, for the purpose of hanging the socket, so that the strain is taken off the binding screws.



PERKINS ELECTRIC SWITCH MFG. CO.'S SOCKET.

NEU'S ELECTRIC LEAK AND FLOW DETECTOR.

WE illustrate on this page an extremely novel device intended to protect buildings from damage by water. It is especially applicable to any of the automatic sprinkler systems which are being so generally adopted in large warehouses, factories, etc. A short description is given herewith explanatory of its simplicity. A is a small spindle provided with a cam, not shown, which is actuated by a stem F, moving in a cylinder filled with oil and closed by plug E. The spindle A, carries one arm upon which is a friction roller actuating the contact segment, B. The slightest flow of water or other fluid passing through the valve raises the disc and by means of the stem F, cam and lever moves the contact points B, G and C, thus closing the circuit and at once giving an alarm as well as showing on an annunciator just where the trouble is located. Immediately the cause of the trouble has been removed and the flow stopped, the contacts open and drop to their normal position automatically. There is no impediment to the moving of the valve upward, it being so delicate that drawing a pint of water from a six-inch main will give an alarm. Very little current is required to operate the detector, one cell of primary battery being sufficient under ordinary circumstances.

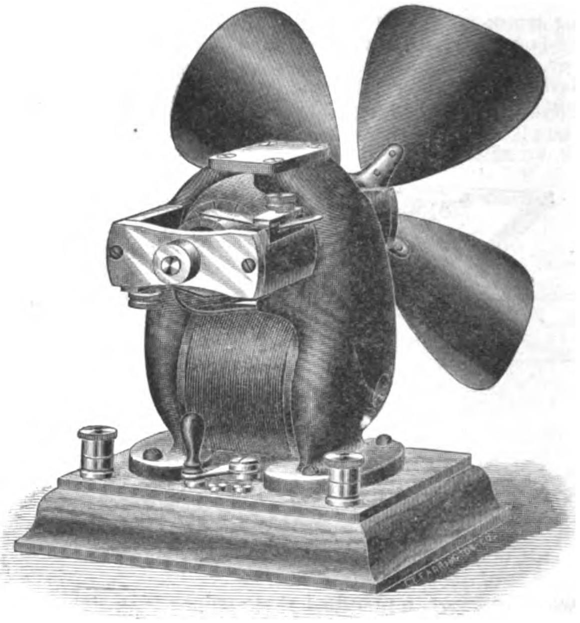


NEU'S ELECTRIC LEAK AND FLOW DETECTOR.

G. S. Neu, of 110 Centre street, New York City, is the inventor and manufacturer of the device.

THE BERNSTEIN FAN MOTOR.

THE accompanying illustration shows a novel and compact form of fan motor recently introduced by the Bernstein Electric Company, of 620 Atlantic avenue, Boston, who claim that it is the smallest and most efficient high-volt motor yet produced. The iron portion is highly enameled and the brass-work finely finished, producing a workmanlike appearance. It is said that the motor runs smoothly without sparking and that the brushes cannot possibly get out of adjustment. Two types are made as shown in the following table:



BERNSTEIN FAN MOTOR.

Type.	H. P.	Speed.	Floor space.	Height without fan.
"I"	1/15	1,700 or 2,000	6 x 6½ in.	7 in.
"G"	1/8	1,600	7½ x 8 in.	9 in.

Several other sizes are made upon the same general lines, intended for heavier work. Agents are wanted everywhere.

QUEEN & CO.'S INSTRUMENTS.

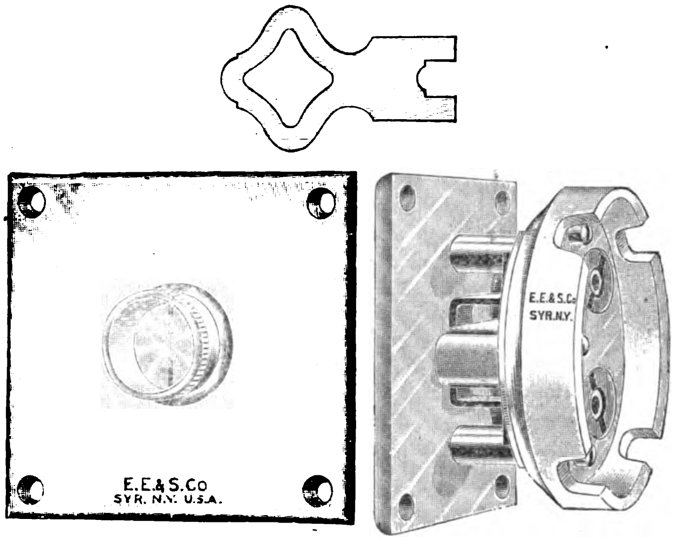
WE are informed by Queen & Co. that they have recently received an order for more than 200 magnetic vane volt and ampere meters from a large manufacturing concern, which instruments are to be installed with the light and power plants put up by this company. The transaction is especially satisfactory to the makers, as a sort of competitive examination was instituted and the magnetic vane type was adopted after careful comparison with other types, as being most suitable in this instance.

APPARATUS WANTED AT PLATTEVILLE, WIS.

MR. W. LOCKWOOD, the superintendent of the Platteville, Wis., Electric Co., writes us that they are in the market for an addition to their plant of a 1,650 incandescent light dynamo, and a power generator, of size not yet determined. They are also in the market for a 1,125 h. p. Corliss engine, to be placed at once.

FLUSH LOCK SWITCH FOR INTERIOR CIRCUITS.

A **very** important feature of electric lighting in residences and fine public buildings is apparatus and equipment that will be attractive and neat. The Electric Engineering & Supply Co., of Syracuse, N. Y., have invented a flush lock switch, illustrations of which are shown below, which is specially adapted to answer this purpose. The working mechanism of this switch is very simple, as shown in the cut, and all parts are warranted by the manufacturers. There is a brass cover which protects all the working parts from any foreign matter when inserted in a plastered wall. All of the switch being entirely concealed, nothing is left to view but the highly finished plate, flush with the wall. This plate can be nickeled, oxidized, engraved or made to match any finish. The striking peculiarity of this switch is its great adaptability for all public buildings, especially for insane asylums and orphanages, where but one person should control the lights. The current can be turned on or off by inserting the key in its receptacle and turning either way, as with the ordinary handle.



Figs. 1, 2 and 3.—Flush Lock Switch.

Upon withdrawing the key, it is impossible for any one to interfere with the lights controlled by the switch. Where it is necessary to place a switch within the reach of children, this device is especially desirable on grounds of safety.

Not only has it these advantages, but it also does away with the unsightly bumps on the walls often seen in the case of the ordinary switch. This company are having repeated calls for these goods, and are at present manufacturing them in large quantities for the trade.

AN ELECTRIC RAILROAD FOR STATEN ISLAND.

Mr. F. R. Chinnock has just sold to a syndicate the franchise for the Prohibition Park Railway, to be operated by a company of that name. The road will run across Staten Island from Port Richmond to Prohibition Park and South Beach, and will be about three and half miles in length. The road will have an Edison equipment of 12 cars, single-reduction gear, and two 100 K. W. generators. The company is now in the market for its steam plant. The syndicate purchasing the franchise, etc., are Royal C. Vilas, president of the New York Air Brake Co.; C. A. Starbuck, and J. C. Thompson, president, of the Eames Vacuum Brake Co. Some of these gentlemen are also interested in the Watertown, N. Y., electric railway. The franchise, which was secured by Mr. Chinnock on February 11, is held to be one that has very great prospective value, although a few months ago it hardly seemed worth getting except to one or two far-sighted men. It is interesting to note that the road will use about 1,100 feet of the Belt Line track. This it does under an order of the court which requires it in return to keep that portion of the road in repair and to allow the Belt Line people use of its terminal facilities. The road will be put in operation as soon as possible in order to get the benefit of this summer's business. The Prohibition Park is a high-class addition to the attractions of beautiful Staten Island.

BARTON & BROWN.

The above firm of attorneys and counselors, Chicago, will remove their patent law offices on May 1, to rooms 1428--1430 Monadnock Building.

UNIVERSAL RADIAL DRILL COMPANY.

The Universal Radial Drill Company, of Cincinnati, Ohio, have issued their calendar for the month of April in their usual style. This time they show their 20-inch swing engine lathe, with the good points of it mentioned on the back of the card.

RAILWAY EQUIPMENT COMPANY.

We publish below the preliminary announcement made by a new company with the above name. Special interest and importance is given to this departure by the fact that it is begun under the direct personal management of Mr. W. R. Mason, who, as is so well known, has made the electric railway field his chosen study, with no small degree of success. We have not yet received any details as to the personnel of the company, but it is understood that it will be fully organized during the current week.

Railway Equipment Company.

Temporary Offices, 617–619 Pullman Building, Chicago.

We beg to call your attention to the above company which has been organized for the purpose of manufacturing and dealing in electric railway supplies for use on all systems. Having had a long and practical experience in all branches of the business, we feel confident of our ability to successfully meet the wants of this branch of the trade. We shall carry in stock large quantities of material needed for the complete equipment and maintenance of electric roads. Prompt shipments can be relied on at all times. We have lately perfected several new line devices which we believe have enough merit to claim the attention of parties about to build or make extensions.

We shall be pleased to advise parties as to the best manner of building and operating such roads. We have no affiliation whatever with any company or individual which will interfere with the exact and impartial conduct of our business. At the earliest possible moment we shall issue a very complete catalogue fully illustrating and describing material of our manufacture and containing valuable data for parties interested in the building or operating of electric roads. In the meantime, we beg to assure the trade that any orders which may be sent to us will be filled promptly and at the lowest market prices.

The writer desires to express to the trade generally his thanks and appreciation of favors granted to him during his connection with a former company, and begs to assure the trade that sincere regard will be paid to their wants and suggestions. Trusting that the conduct of our business may be such as to merit a share of your patronage, we are

Very truly yours,

Railway Equipment Co.,
W. R. Mason.

ORDERS FOR "IDEAL" ENGINES.

The following are among the recent orders received by the Harrisburg Foundry and Machine Works, of Harrisburg, Pa.: Two 10 and 17 x 14 tandem compound Ideal engines, for St. Paul, Minn.; one 18 x 12 plain Ideal engine for St. Paul; three 125 h. p. Ideal engines with corresponding steel return tubular boilers, also pump, heater, piping, etc., for Wilkesbarre and Wyoming Valley Traction Co.; two 18½ x 18 plain Ideal engines for New York City; one 13 x 18 standard Ide engine for Boston; one 125 h. p. standard Ideal engine, steel return tubular boiler, heater, piping, etc., for Georgetown and Tenallytown Electric Railway, Washington; two steel return tubular boilers, for the Allentown Electric Light Company; one 60 h. p. standard Ide engine and steel return tubular boiler for manufacturing purposes, Newville, Pa.; one 25 h. p. Ideal engine and one 50 h. p. Ideal engine for U. S. Naval Observatory, Washington, D. C.; one 50 h. p. engine and steel return tubular boiler for manufacturing purposes, at Newport, Pa. Besides these, they have a number of small Ideal engines ordered for New York City.

HIGH INSULATION RESISTANCE OF RAILWAY INSULATORS.

In a recent issue we mentioned some tests made of the electric railway insulators of Albert & J. M. Anderson, of Boston, and stated that their insulation was found to be 156,000 ohms. We now learn that they were tested up to the very high figure of 156,000 megohms. The tests were made by the Massachusetts Electrical Engineering Co., who say: "The resistance of these insulators was obtained by the direct deflection or substitution method largely used at present for the measurement of high resistances. The voltage used was about 1,100, and a constant sufficiently large to measure to 300,000 megohms was easily obtained. One-minute electrification of the insulator was allowed in each case."

Trenton, N. J.—The People's Electric Light Co. will install at once a 50 K. W. generator to operate motor circuits of 250 volts. This company has taken the matter of handling live wires during a fire into their own hands. At the central station is kept a "St. Louis trimmer's cart" filled with all emergency tools. Both horse and harness are always ready for an alarm of fire, and are generally on the ground ahead of the fire department. The company says this arrangement has proved a paying institution. The Field Engineering Co. are pushing the electric railway rapidly. An unfavorable decree was recently given in court in regard to the State street trolley line, but elsewhere there will be no difficulty.

NEW YORK NOTES.

Doubleday, Mitchell & Co. have secured very desirable quarters in the Electrical Exchange Building, where they will continue to handle the well-known Columbia incandescent lamp, and the specialties of the Consolidated Electric Manufacturing Co. They have just completed arrangements for the representation of the products of the American Circular Loom Company of Boston. They will supply these goods to buyers in New York, New Jersey and Pensylvania.

The Short Electric Railway Co. have removed from the *World* Building to the Mills Building, 35 Wall street. The change has been made imperative by the increase of business and the need for more room. The company will have in their new office a fine display of Short railway apparatus, and every convenience for the transaction of business. Mr. Edward J. Wessels, the special agent, will have his headquarters there.

Search Lights.—Unprecedented success in the introduction of the excellent search light manufactured by the Electric Construction and Supply Co. has had the effect of bringing in such a large number of orders from steamship and transportation companies generally that the manufacturers of these lamps are compelled to work their large force of employees well-nigh on to the "wee sma hours."

The Roy Valve Company, 15 Cortlandt street, are sending out a nicely illustrated catalogue and price list. The little book also contains valuable testimonials as to the very desirable work done by their valves under severe tests. Although but a short time on the market, the "Roy" valve has proven a "winner."

Stanley & Patterson, manufacturers of electrical house furnishings, are about ready to place on the market several specialties of interest to the supply trade. They are sending out a very neat pocket price list and catalogue containing some illustrations of their novelties.

Mr. Ralph L. Shainwald, of the Standard Paint Co., makers of the famous P. & B. compound, has just returned from a flying visit to Chicago and Detroit. The run was a most successful one, several handsome contracts making the return trip with Mr. Shainwald.

Dr J. Graham Scott died at his home, No. 17 East Twenty-first street, last week of acute rheumatism. He was born in Philadelphia on September 10, 1849, and was educated at Jefferson College. He practiced his profession for a time in San Francisco and then came to New York, where he organized the Scott Electrical Manufacturing Company, of which he was president and general manager. He contributed many articles on medical and electrical subjects to various journals and periodicals.

WESTERN NOTES.

The Electric Appliance Company have closed arrangements to represent the Security Insulator Company in the West, and will carry a large stock of their specialty. The Security insulator is one of the most notable of the recent improvements in the direction of a higher grade of material for construction. It combines the desirable features of both insulator and cleat. By its use the wire is held firmly by the insulator without the use of tie wires or other fasteners. The greater the strain on the wire, the tighter it is held by the insulator, but without in any way injuring the insulation. Another point in its favor is that its contact with the wire has the smallest possible surface, thus increasing the insulation resistance of the line.

The Franklin Electric Company, of 535 Delaware street, Kansas City, has secured the contract for wiring the Capital Building at Topeka, Kan. It is also putting in a 500-light Edison plant at Rockport, Mo., and has been retained as constructing engineer for Pierce City, Mo. All this work has come in during the past week.

The Western Electric Co. has just begun wiring the new German Opera House at Chicago and will use Simplex wire throughout. No wonder George Cutter is wearing a Sunday-go-to-meeting smile on week days!

Gladstone, Mich.—Edwin J. Tice has secured a 24-year franchise and has contracted with the Edison General Electric Co. for a 1,000-light plant. A full company has not yet been formed.

The United States Electric Light Company has been awarded the contract for two 800-light dynamos for the Jackson county court house, Kansas City.

CANADIAN NOTES.

The Toronto Construction and Electrical Supply Co., office and salesrooms 63, 65, 67 and 69 Front street, west, Toronto, has issued its first catalogue. It is a very handsome and interesting production of quarto size, well printed and solidly bound. It enumerates a large variety of apparatus and supplies, with prices, etc., and shows every sign of enterprise and business acumen.

NEW ENGLAND NOTES.

O. S. Platt.—The factory of O. S. Platt, Bridgeport, Conn., manufacturer of the well-known New England switch, has been taxed to its utmost capacity for some months past turning out these excellent switches. There is no doubt that with improvements recently made in this switch it is one of the best on the market. The contact bar is now arranged so as to slide up and down a standard instead of moving in a saddle as heretofore. This leaves a nice space inside with plenty of room for making connections, leaving little chance for short-circuits, etc. Another improvement is the placing of a fibre collar on the outside of the shell. This collar is supplied with an inner thread, which when screwed up prevents the loosening and dropping down of the shell, which is a disagreeable feature in a great many switches. A very handsome flush switch, also manufactured by Mr. Platt, has been in great demand for several months. He also makes a specialty of the manufacture of dynamo gas igniters.

The Berlin Iron Bridge Co, of East Berlin, Conn., have taken the contract to build a producer building for the Solvay Process Co., of Syracuse, N. Y. The building will be 30 feet wide, by 100 feet long and three stories high built entirely of iron, even the floors being made of plate iron in order that there may be no woodwork about the building to take fire.

HUDSON RIVER NOTES.

Cohoes, N. Y.—The directors of the Troy and Lansingburgh Railroad have been endeavoring to secure the consent of property owners on Remsen and Main streets for a new road to be operated by electricity from the stone bridge, North Mohawk street, to Remsen, to White, to Main, to Saratoga street and thence to Troy via the White line. If the company is successful in securing the consent asked for, the Mohawk street branch from Ontario to the junction of Main and Saratoga streets will probably be abandoned, and the White line cars will then run over the new route.

Troy, N. Y.—The Troy City Railroad Company has secured a site for the power station, by a purchase from the Marshall estate. Consideration $2,000. The station is to be of brick, 100 x 90 feet, with high-truss iron roof. Plans have already been prepared by Architect McIntyre, of New York City, and the work of construction will begin as soon as the weather permits. It is the intention of the management to hasten the electrical equipment of the road, and the promise has already been made of electric cars running by June 1, next.

Newburgh, N. Y.—The Edison Illuminating Company are to add at once 200 h. p. of dynamos to their plant. These will be set up temporarily until a new station can be built. The Newburgh Electric Light and Power Company will also rebuild at once. Their plant is at present overloaded, although a 65-light arc and a 650-light alternator have just been started.

West Troy, N. Y.—The dynamo for the additional lighting recently contracted for by the village trustees, has at last arrived, and is now being placed in position. The additional lights ordered have been located and wires strung, so that it is expected the power will be supplied in a very few days.

West Troy, N. Y.—The works of J. M. Jones & Son, at West Troy, present a very lively appearance. A number of large orders have been lately received including one for 150 double trucks for the West End Street Railway, Boston. The company has a well-established reputation for the highest class of work.

Poughkeepsie, N. Y.—The Poughkeepsie Electric Light and Power Company will at once enlarge and remodel their station. It is intended to replace all the high-speed engines with low-speed. Probably the electric railway will also be built soon.

PHILADELPHIA NOTES.

The "King" Annunciator made by Partrick & Carter Co., of Philadelphia, is one of the most successful specialties ever introduced by that house. It fills all the requirements of a low-priced and perfect working annunciator, and is just the thing for contract work where the finely finished instruments are not demanded.

At a recent election of the Indianapolis Brush Electric Light and Power Company, Indianapolis, Ind., John Caven, Indianapolis, was elected president; J. Potter, Cleveland, Ohio, treasurer; S. M. Hamill, Cleveland, Ohio, secretary; John Caven, J. Potter, S. M. Hamill, directors.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XIII. APRIL 27, 1892. No. 208.

A PHOTOGRAPHIC STUDY OF NON-ARCING METALS.

BY

Alexander Jay Wurts.

MR. R. G. FESSENDEN, in his article[1], has described some very interesting experiments which he has performed in his investigation of the causes for the suppression of the arc, and the results of these experiments seem to have inclined him to the theory that a pure vapor of the metal is formed between the electrodes, rather than a vapor consisting of the oxide of the metal.

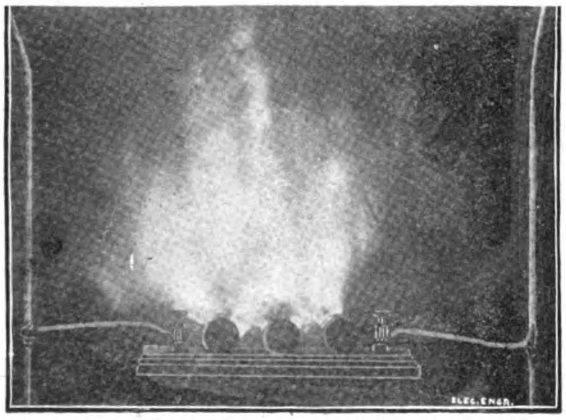


FIG. 1.

In connection with my original experiments, the question naturally occurred to me as to what was the real constitution of the vapor which appeared to be formed, and while I felt that it might be a pure metal vapor, I have always been somewhat inclined to the theory that there is an oxide present. I did, however, at one time test the non-arcing property of metals with electrodes immersed in a hydrocarbon oil, and found that under these circumstances I was unable to maintain a thousand-volt short-circuit across two air-gaps of $\frac{1}{32}$ of an inch each.

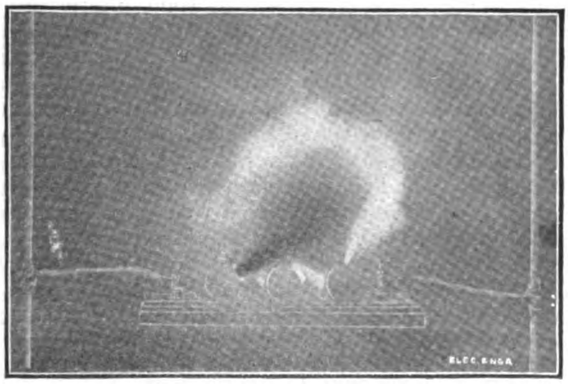


FIG. 2.

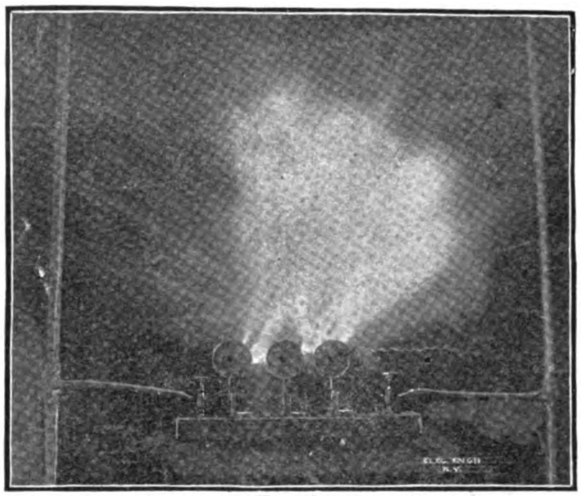


FIG. 3.

This result seems to indicate that the vapor contained no oxygen, because none could be present within the oil, and yet there are other considerations which favor the idea that the vapor is usually wholly, or at least in part, an oxide. Thus, each of the pure non-arcing metals under the conditions of a short-circuit deposits on the surfaces of the electrodes an oxide which in each case possesses the characteristics of some oxide of the particular metal used. Possibly, however, the pure-metal vapor theory is the correct one, and I am pleased to see it discussed.

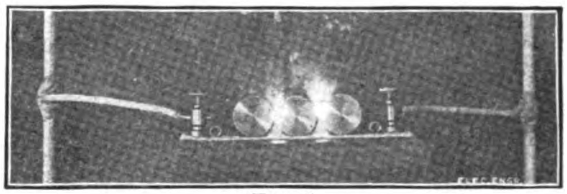


FIG. 4.

It is interesting in this connection to notice that all of the non-arcing metals thus far pointed out are notably diamagnetic. This may be only a coincidence, or there may be in reality some relation between the diamagnetic and the non-arcing properties of metals. Thus, bismuth, antimony, zinc, cadmium and mercury are all peculiarly diamagnetic. Lead also is a diamagnetic metal, and I have made some interesting and satisfactory experiments with it. Although lead has been notorious for its arcing powers when used as a fuse, yet it must be remembered that in order to obtain the non-arcing effects with high potential currents, the air-gap must be exceedingly small.

I therefore made a set of three lead electrodes or dischargers, giving two air-gaps of $\frac{1}{32}$ of an inch each, and, on testing, found that at the instant the short-circuit was established, the arc seemed to hesitate, but the lead quickly reaching its melting point, the small air-gaps were destroyed, and the arc then assumed large proportions. I then repeated the test, this time taking precautions to avoid, if possible, the melting of the lead. For this purpose I made a set of three dischargers, as before, consisting of 50 per cent. copper and 50 per cent. lead, upon the theory that if lead is a non-arcing metal there would be a sufficient quantity of that metal present to suppress the arc, just as in the zinc-brass electrodes there is a sufficient quantity of zinc to interrupt the short-circuit while the copper adds toughness to the electrodes. My tests with the lead-copper electrodes were singularly successful, and upon examining the electrodes after three consecutive tests I found that each short-circuit had formed a small smooth spot upon the surfaces of the electrodes, and that a globule of lead seemed to have been drawn to the surface at these points.

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[1] THE ELECTRICAL ENGINEER, April 6, 1892.

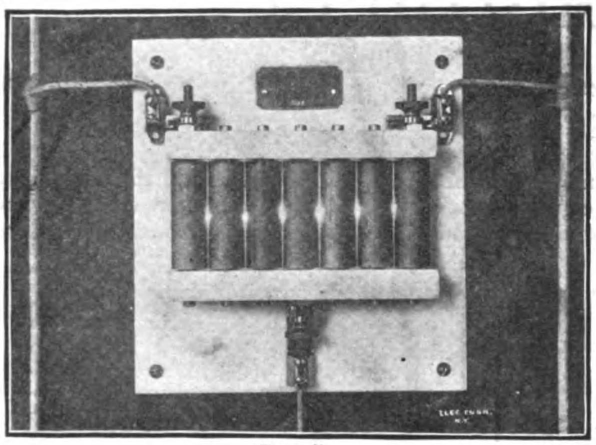


FIG. 5.

The diamagnetic properties of tin are well known, and it is therefore interesting to note that this metal seems to be entirely devoid of non-arcing properties; even a mixture of tin and copper, forming a tin brass, possesses none of the qualities which are so manifest in the case of zinc brass.

I have recently taken some photographs of the arcs between electrodes of non-arcing metals for the purpose of studying the results and gaining further information upon this interesting subject. The different results obtained by the use of small and large air-gaps are especially noticeable in these photographs.

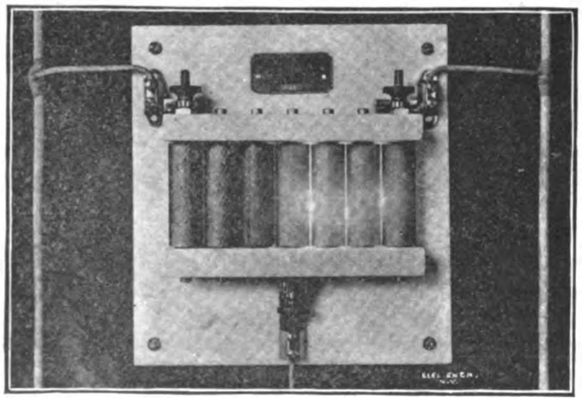


FIG. 6.

Fig. 1 illustrates a 1,000-volt short-circuit across two air-gaps of $\frac{5}{8}$-inch each and between non-arcing metal electrodes.

Fig. 2 is a view of a similar short-circuit across the same air-gaps.

Fig. 3 represents a 1,000-volt short-circuit across two $\frac{1}{2}$-inch air-gaps.

Fig. 4 is a similar short-circuit across two $\frac{1}{16}$-inch air-gaps. In this case the arc was mostly due to the fusing of the tinfoil used in starting the arc, for the circuit was instantly interrupted without injury to the electrodes.

Fig. 5 represents a non-arcing metal lightning arrester suitable for 1,000-volt incandescent alternators and alternating current and pulsating current arc machines. The air-gaps are $\frac{1}{32}$ inch and the arcs shown are due to the short-circuit of a 1,000-volt incandescent alternator. With $\frac{1}{32}$-inch air-gaps the interruption of the short-circuit is instantaneous and merely causes an almost imperceptible flicker in the voltmeter.

Fig. 6 represents the short-circuit across three air-gaps of the same arrester, which in actual practice would be from line to ground. After repeated short-circuiting these non-arcing metal cylinders are not roughened or burred sufficiently to be preceptible to the touch. The short-circuit, however, leaves a small bright spot surrounded by a black deposit, the latter being presumably caused by the fumes of the tinfoil used for starting the arc.

Fig. 7 illustrates a 1,000-volt short-circuit across two $\frac{1}{16}$-inch air-gaps between carbon electrodes.

There are two curious features to be noticed in connection with these figures: First, the reduction of the arc with the reduction of the air-gap; second, the apparently violent repulsion of the arc between non-arcing metal electrodes as compared with the evenly diffused arc between the carbon electrodes. In connection with diamagnetism, these repelling arcs are very suggestive.

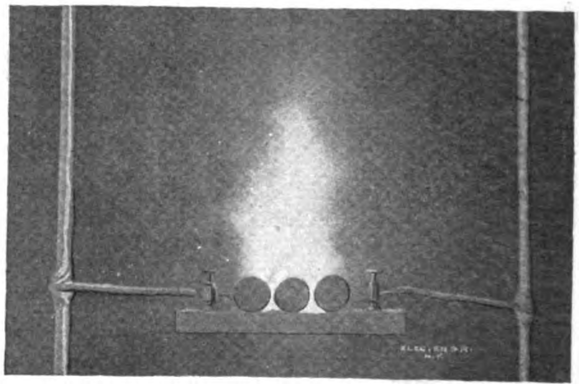


FIG. 7.

SELF-DISCHARGE OF ACCUMULATORS.

DR. KRÜGEL, of Berlin, gives an account in the *Elektrotechnische Zeitschrift* of the result of some interesting and important observations upon the discharge of the negative plates of secondary cells on open circuit. The observations were carried out upon Tudor cells. In an installation it had been remarked that the capacity of a battery was much less than that guaranteed, and that the battery, left by itself, became discharged in a few hours. A careful examination showed that the negative plates only were discharged, the metallic lead becoming oxidized with much disengagement of hydrogen. Other negative plates were put in their place after a strong charge, and the battery now acted well. Numerous tests and analyses showed that the cause was due to the presence of foreign metals dissolved in the electrolyte, which were deposited during charge on the negative plates, where they form couples with the reduced lead. In particular, in the acids giving this effect were found copper, arsenic, antimony, molybdenum, and platinum, the latter having a decided effect even if only in quantities of one-millionth. The manufacturers now only use the acid after having precipitated the metals by sulphhydric acid.

SCIENTIFIC ELECTRO-MEDICAL APPARATUS.

BY

James Bowstead Williams M.D.

The accompanying illustration is reproduced from a photograph of electro-medical and surgical apparatus, invented and made by the writer for his own use while a practitioner of medicine in San Francisco, Cal.

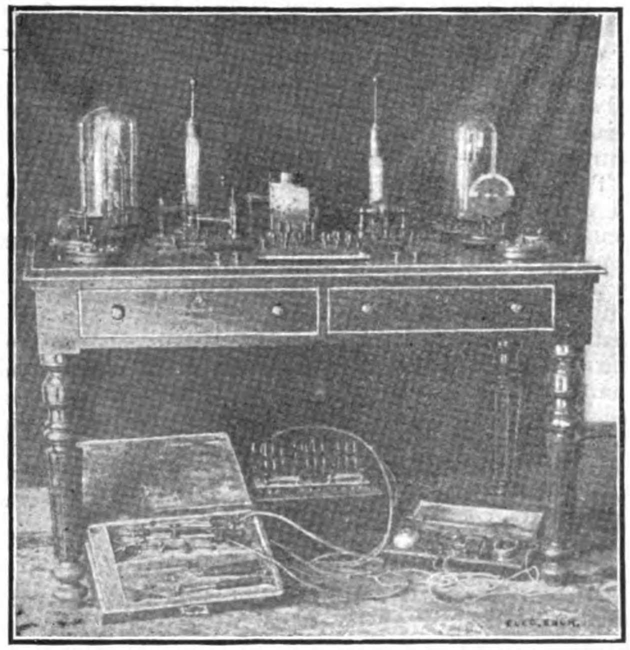
The electro-medical apparatus, shown upon the table was considered to be the first complete apparatus of its kind ever made. It was first illustrated and described in the *Mining and Scientific Press*, of March 12, 1881, published in San Francisco, and the description was subsequently copied into other journals. This apparatus complete consisted of the following named instruments: 1. A battery of 60 gravity cells. 2. Two circular switches, for selecting the current from any number of cells without interrupting it while being increased or diminished. 3. A cylindrical commutator, for reversing the current from the battery. 4. A combined commutator and interrupter, driven by a belt and pulleys, for rapidly reversing or interrupting the galvanic current. 5. A six-lever switch, for switching the battery current, without interruptions, into and out of the principal parts of the apparatus. 6. An upright galvanometer, for testing the current from the battery, and, when used with the switches above named, to indicate the position of breaks or crosses, whether in the battery, the various instruments, or the connections of the apparatus. 7. An astatic galvanometer, for indicating the strength of the galvanic current while passing through the human body, or parts thereof. 8. A faradic rheotome, capable of being adjusted to a wide range of vibrations per second. 9. An induction coil containing two primary and six secondary helices, enclosing a bundle of annealed iron wires. The electromagnets of the rheotome and the primaries of the coil were so wound that the two instruments could be operated by *any* number of cells of the battery. 10. A rheotome, driven by clockwork, for interrupting the galvanic current (the faradic also, if desired) 1, 2, 4, 8, 12, and 16 times per second. 11. Two upright water rheostats, used as shunts for regulating the strength of the Faradic and galvanic currents. 12. A condenser for use with the induction coil, when severe shocks were to be administered. 13. Plug and lever switches, for controlling the action of the different parts of the induction coil, rheotomes, etc.

These instruments were suitably joined together and to the battery by insulated wires secured to the under surface of the table, and they could be used singly or in combinations by means of the various switches, according to their functions. After passing through the instruments, the faradic and galvanic currents were conducted to two pairs of binding posts, and from these, through conducting cords, to the electrodes, for application to all portions of the human body.

The surgical apparatus—that shown underneath the table—consisted of a galvano-cautery with a complete set of electrodes, and a bullet explorer. The generator of the galvano-cautery consisted of nine zinc and twelve perforated carbon plates, each six inches square, placed in three prepared wooden cells which contained the exciting solution. All of the plates were permanently secured to the cover of the cells. By means of switches, the three cells could be used in series, or in multiple arc. Each zinc was connected with a compound switch, by means of which it could be instantly joined electrically with *any* other zinc, or disconnected from it, by simply raising or lowering a lever, no matter how many of the cells were being used, or how they were joined up. As the plates were large, and the battery fluid strong, abundant, and very constant in strength, the current from three zincs, (and their accompanying carbons), whether belonging to the same cell or to different cells, was sufficient to heat all the electrodes, except those which contained a considerable length of platinum wire. This being the case, the value of the compound switch will readily be appreciated, since when one set of plates became polarized, another set could be instantly substituted for the first, by the mere raising and lowering of levers.

This cautery, completed in 1882, was first described in the *Mining and Scientific Press*, and afterwards favorably noticed on the editorial page of the *Electrical World*, of October 11, 1884. All of the electrodes of the cautery were contained in one case—that shown in the centre—and were of original and special design.

The bullet explorer consisted of three parts: The electrodes, flexible conducting cords, and a case containing battery, indicators, and switches. Each electrode consisted of a vulcanized rubber tube, about 13 inches long, containing two fine insulated copper wires. Each wire terminated at one end in a binding-screw, and at the other, in a small ball of pure gold. The gold balls were fastened in conical pieces of hard rubber of various sizes and shapes, and were so arranged that both would make contact with either flat, convex, or concave surfaces. The electrodes were of various degrees of flexibility, so that they could follow the paths made by bullets, whether the paths were straight or crooked.



THE WILLIAMS ELECTRO-MEDICAL APPARATUS.

The indicators consisted of a vibrating bell, and an upright detector, either of which could be used by means of switches. They were operated by one or two bichloride of mercury cells. The conducting cords were about eight feet long, and, with the electrodes, could be packed in the case.

The operation of the explorer was quite simple. The apparatus being properly arranged, as soon as the balls on the electrode or probe came in contact with a piece of metal, a circuit was established through the metal, electrode, conducting cords, etc., and the bell would ring, or the needle of the detector be raised from a normal horizontal position, according as the bell or the indicator had been connected by means of the switches.

This explorer was completed in 1885, and was described in an editorial in the *Mining and Scientific Press*, and noticed in other papers.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—IX.

BY

Francis B. Crocker and S. S. Wheeler.

CHAP. VII.

DIRECTIONS FOR TESTING DYNAMOS AND MOTORS.

THE matter of testing dynamos and motors is of special importance since it is only by a thorough test that either the manufacturer or the user can determine whether a certain machine is up to the standard. Nevertheless it is difficult, if not impossible, to find in books or journals anything like a complete system of testing methods applicable to dynamos or motors. Each electrical manufacturer or engineer has collected by experience certain methods, but these usually apply to particular forms of machine or testing apparatus and moreover are often guarded as trade secrets.

The following methods cover the various facts about a dynamo or motor which one is likely to want to test. Under each heading exact methods are given which should, of course, always be preferred; but wherever possible we have also given simple, rough methods for emergencies or other cases in which a dynamo or motor may have to be tested without the accurate and expensive instruments required for the more refined methods.

This subject differs from our chapter on "Locating and Remedying Troubles in Dynamos or Motors," in the fact that the other relates to actual faults which are already apparent, whereas testing applies to any machine whether in perfect working condition or containing some latent fault which a test brings out and anticipates. The testing methods here given can also be used as supplementary to the methods for locating troubles in cases where a more complete investigation may be desirable. In testing any machine it is well to follow as nearly as possible the directions given by its maker and try it under the conditions for which it is intended, in regard to voltage, current, speed, etc. Tests of dynamos and motors may cover any or all of the following points:

1. ***Adjustment*** and fit of parts.

2. ***Mechanical Strength*** of parts against breaking or displacement.

3. ***Friction*** of bearings and brushes.

4. ***Balance*** of armature and pulley.

5. ***Noise.***

6. ***Electrical Resistance*** of conductors and insulation.

7. ***Voltage,*** E. M. F., "drop" or fall of potential, etc.

8. ***Current*** in field, armature free and loaded.

9. ***Speed*** of armature, free and loaded.

10. ***Torque or Pull,*** standing or running.

11. ***Power,*** electrical and mechanical.

12. ***Efficiciency,*** electrical and commercial.

13. ***Heating*** of armature, field magnet, bearings, etc.

14. ***Sparking*** at commutator.

15. ***Magnetism,*** total flux, intensity, leakage and distribution.

16. ***Line or Circuit*** testing for resistance, insulation, faults, etc.

1. ***Adjustment*** and the other points which depend merely upon mechanical construction are hardly capable of being investigated by a regular quantitative test, but they can and should be determined by thorough inspection. In fact a very careful examination of all parts of a machine should always precede any test of it. This should be done for two reasons, first, to get the machine into proper condition for a fair test, and second, to determine whether the materials and workmanship are of first-class quality and satisfactory in every respect. A loose screw or connection might interfere with a good test, and a poorly fitted bearing, brush holder, etc., might show that the machine is badly made.

If it is necessary to take the machine apart for cleaning or inspection the greatest care should be exercised in marking, numbering and placing the parts in order to be sure to get them together in exactly the same position as before. In taking apart or putting together a machine, only the minimum force should be used. Much force usually means that something wrong is being done or in a wrong way. A wooden mallet is preferable to an iron hammer, since it does not mar or strain the parts so much. Usually screws, nuts and other parts should be set up fairly tight but not tight enough to run any risk of breaking or straining anything. Shaking or feeling each screw or other part will almost always show that some one or more of them are too loose or too tight, or otherwise out of adjustment.

2. ***Mechanical Strength*** of a dynamo or motor is best specified by stating that it should be above question. The base, bearings, shaft, armature, field magnets and other main parts of the machine should not spring even one one-hundredth of an inch with any reasonable force that may be applied to them. There has long existed a craze for very light dynamos and motors, as a result of which, strength, rigidity, durability and satisfactory qualities in general have been sacrificed to reduce weight. There is certainly no sense in this. For stationary machines and even for ship dynamos or railway motors good solid frames, bearings, etc., are much better than light ones.

The magnetic attraction between the field and armature is often very great, and may amount to hundreds, or even thousands, of pounds. This tends to draw the pole-pieces against the armature, or spring the armature shaft if the armature is even slightly nearer one polepiece than the other. It is well to magnetize the field by putting the proper current through its coils and see if it produces any reduction of the clearance or other displacement that is appreciable to the eye or even to any ordinary measurement. The effect of the maximum pull of the belt or any other legitimate stress may be tested in the same way.

In addition to this all the parts of the machine should be scrutinized to see if they are of adequate size and proper proportion.

3. ***Friction.***—The friction of the bearings and brushes can be tested roughly by merely revolving the armature by hand and noting if it requires more than the normal amount of force. Excessive friction is quite easily distinguished even by inexperienced persons. Another method is to cause the armature to revolve by hand or otherwise and see if it continues to revolve by itself freely for some time. A well-made machine in good condition will continue to run for one or more minutes after the turning force is removed.

A method for actually measuring the friction consists in attaching a lever (a bar of wood, for example) to the shaft or pulley at right angles to the former. The force required to overcome the friction and turn the armature without current is then determined by known weights or, more conveniently, by an ordinary spring balance. The friction of the bearings alone, that is, the pull required to turn the armature when the brushes are lifted off the commutator and there is no current or magnetism in the field, should not exceed 1 per cent. of the total torque or turning force of the machine at full load. When the brushes are in contact with the commutator with the usual pressure, the friction should then not exceed 2 per cent., that is, the brushes themselves should not consume more than 1 per cent. of the total turning force. When the field magnetism is at full strength, and the brushes are on the commutator, the maximum friction or pull required to turn the armature should, then, not exceed 4 per cent. of the total torque.

This torque or pull in pounds in the case of any machine may be calculated by the formula:

$$\text{Torque} = \frac{\text{H. P.} \times 33{,}000}{6.28 \times R \times S}$$

in which H. P. is the horse-power of the machine at full load, R is the radius or length in feet of the lever used in the test, and S is the speed of the machine in revolutions per minute at full load.

Another method of measuring the friction of a machine is to run it by another machine used as a motor and determine the volts and amperes required, first, with brushes lifted off and no field magnetism; second, with brushes on commutator but no magnetism; and third, with full strength of field magnetism giving maximum friction. The torque or force exerted by the driving machine is afterwards measured by a Prony brake in the manner described hereafter for testing torque; care being taken to make the Prony brake measurements at exactly the same volts and amperes as were required in the friction tests. In this way the torques which were exerted by the driving machine to overcome friction in each of the three first tests are determined, and these torques compared with the total torque of the machine being tested, as calculated by the formula just given, should give percentages not exceeding those stated above for the maximum values of friction.

Tests for friction alone should be made at a low speed because at high speeds the effect of Foucault currents and hysteresis enter and materially increase the apparent friction.

THEORETICAL ELEMENTS OF ELECTRO-DYNAMIC MACHINERY—II.[1]

BY

A. E. Kennelly

POTENTIAL.

ANY steady distribution of magnetic flux is subject to a potential except within the substance of conductors carrying electric currents. That is to say, it is possible to assign to each point of the field a numerical value, such that its gradient, or rate of change in any direction shall represent the corresponding component of flux intensity in that line. In recognizing a distribution of potential in space, we therefore erect everywhere an imaginary numerical scaffolding, each point being invested with its appropriate magnitude and sign. The direction of maximum gradient in the scaffolding at any point, is the direction of the flux, the steepness of the grade being the flux intensity. The plane normal to the direction of maximum gradient will also be the local plane of no gradient or of level potential. If surfaces are formed by the colligation of all points having equal potentials, they will be equipotential surfaces. There will be no flux in the plane tangential to such a surface, and the whole flux will be normal to them. It is also evident that the steeper the grade, the closer will be the successive equipotential surfaces, just as in the case of contour lines on a map of levels; so that where the flux density is great the surfaces follow in rapid succession, spreading apart again where the intensity is low.

In fact, the intensity is the reciprocal of the distance between adjacent surfaces whose potential differs by unity, as represented by the equation:

$$B = -\frac{dP}{dn};$$

where P is the potential and n the distance measured along the normal to the equipotential surface, a condition condensed into the notation

$$B = -\nabla P.$$

The negative signs are here appended in order to preserve the convention that the direction of the flux shall be down grade, or the direction in which the potential falls.

If the maximum gradient of potential at a given point is at the rate of, say, 500 units (ergs) per centimetre of distance, the flux density at the point will be 500 C. G. S. lines per square centimetre. As the conception of magnetic potential has important practical applications, we shall proceed to examine its distribution in a few cases.

The simplest instance is probably that of an indefinitely long straight wire of circular section carrying a steady current. Fig. 8 represents a plane drawn perpendicularly through such a wire, carrying a current of 100 / 4 π, or 7,958 C. G. S. units (79.58 amperes, since the absolute unit of current in the electromagnetic system is 10 amperes). The reason for selecting this particular current strength is merely to secure graphical simplicity. The current is supposed to be passing upwards through the wire from the plane towards the reader. The equipotential surfaces for such a wire are radial planes through the axis. They commence, however, not at the axis itself, but at the surface of the wire, because within the substance of the conductor there is no potential, and they have no exterior boundary, or, in other words, terminate at infinity. The traces of 10 such radial planes are shown equidistant in the diagram, and on each of these the potential has a constant value. Selecting any one plane as O B, we find, however, no determination of its absolute numerical value from the conditions of the problem, and we may therefore assign to this plane any numerical value we please, positive, negative, or zero; but having once selected it, the whole system immediately assumes definite numerical configuration.

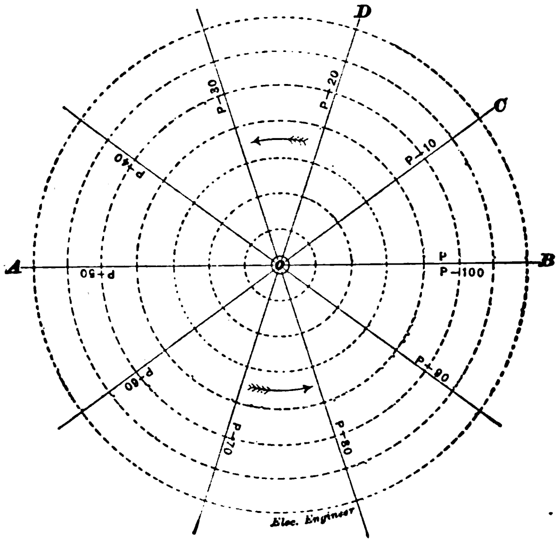


FIG. 8.

Call the potential of OB, P, then the conditions determine that the potential of O C will be $P - 10$; that of O D will be $P - 20$; and so on. Between any two successive planes here represented, it would of course be possible to insert nine equidistant and intermediate planes whose potentials would differ by one unit in succession, while any number of other planes might again be crowded between the unit planes, representing definite intermediate fractional potentials.

Since the flux density is the rate of fall of potential, it is clear that B must have the direction down grade as shown by the arrows, and that it must be at each point normal to the radial plane or tangential to the circle drawn through the point and concentric with the wire. The flux will thus be confined to concentric circles and a few of these whose number is unlimited are represented in the figure by the dotted lines. A free north-seeking pole brought to any point of the field would be carried by the flux round the circle passing through that point in the direction of the arrows.

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[1] Copyrighted 1892 by A. E. Kennelly.

It is evident from the figure that the distance between any pair of equipotential planes increases uniformly with the distance from the axis; and since the flux is inversely proportional to the distance of these planes, it follows that the intensity varies inversely as the distance from the axis.

If we follow the potential down grade from plane to plane, and complete a circle round the wire, we find that the plane O B which at the outset had the potential P now assumes the potential $P - 100$. Also a second circuitation finds this potential changed to $P - 200$, and so on, for any number of turns. The potential of any plane is thus capable of an indefinite number of values successively differing by 100. In other words the potential is cyclic and multiplex. The gradient is definite, but the absolute elevation above datum is indeterminate. This cyclic property is characteristic of magnetic potentials which are typically radial planed, as opposed to electric or gravitational potentials which are typically represented by successive envelopes round a common nucleus.

MAGNETOMOTIVE FORCE.

The simple law of potential applicable to the case of a long current-conveying wire, is that the magnetomotive force in any loop surrounding a steady current of c C. G. S. units is $4 \pi c$. This important quantity, magnetomotive force, is that which produces flux. It is convenient to represent it for brevity by the initials M. M. F. in imitation of the analogous term electromotive force in the voltaic circuit, and its recognized symbol E. M. F.

M. M. F. and flux standing to each other in the relation of cause and effect, one cannot exist without the other. In the great majority of cases with which we are familiar, the flux is subject to a potential such as we have above traced, and in all these cases the M. M. F. between any two points is essentially, and numerically, the difference of potential existing between them. The M. M. F. may be stated as producing the difference of potential, or to be the equivalent of the difference of potential itself; but just as in the voltaic circuit, it is possible to have flux where no system of potentials can exist, and it is advisable to observe that potential differences are only a sub-class of motive force. For example, we have observed that no system of magnetic potentials exists within the substance of the long, straight, current-conveying wire; yet there is flux within it at every point except on the axis itself, and consequently there must be M. M. F., but no such distribution that its space gradient corresponds to the flux.

Outside the wire, the M. M. F. or total P. D. (potential difference) is $4 \pi c$ for one complete circuitation, and since the potential at any point is dependent only on the angle contained between the radial planes through that point and some point of reference, it is clear that the potential varies by $4 \pi c$ for each revolution of 2π, or by $2 c$ per radian in circular measure, $\left(\frac{4 \pi c}{360}\right.$ per degree of common measure.$\left.\right)$

Let the plane through O B be the plane of reference, θ and r the polar co-ordinates of any point a. Then having P the potential assumed for O B, and P_a the potential at O a, we have:

$$P_a = P - 2 c \theta.$$

Again, to find the flux intensity at a we have only to differentiate the potential there in the direction along the path of flow, or tangential to the circle, thus:

$$B_a = -\frac{d P_a}{d s} = -\frac{d}{d s}(P - 2 c \theta) = -\frac{d}{d \theta}(P - 2 c \theta) . \frac{d \theta}{d s}.$$

Also, $\theta = \frac{s}{r} \therefore \frac{d \theta}{d s} = \frac{1}{r}$, while P is constant and

$$B_a = \frac{2 c}{r}.$$

From this it follows that the C. G. S. flux at any point near a long straight wire carrying a current is equal to the C. G. S. current strength divided by half the distance from the axis of the wire in centimetres, and is directed tangentially to a circle drawn through the point concentrically with the wire, in the normal plane.

As a practical application of this result, we can readily determine the deviating influence of such a current-conveying conductor, on a small magnet suspended in its vicinity. Suppose the needle suspended horizontally about its axis directly over and 40 centimetres away from a very long horizontal wire lying in the magnetic meridian, and carrying a current of 20 amperes (2 C. G. S. units), the earth's horizontal component of flux being 0.2 C. G. S.

The flux intensity due to the current at the position occupied by the needle will be $\frac{2 c}{r} = \frac{2 \times 2}{40} = 0.1$. Each pole of the needle will therefore be acted upon by two horizontal component fluxes, one along the meridian plane due to the earth's M. M. F., and $= 0.2$, the other at right angles to the meridian plane, due to the M. M. F. of current, and $= 0.1$.

The resultant of these rectangular components will be $\sqrt{0.04 + 0.01} = \sqrt{0.05} = 0.2236$ and its direction will make an angle $\tan^{-1} \frac{0.1}{0.2} = \tan^{-1} 0.5 = 26^\circ . 34'$ with the magnetic meridian. The needle will assume the local direction of resultant flux, and deflect through this angle on the establishment of the current. The direction of deviation will, of course, depend on the direction of the current in the wire, but the deviation of the north pole will always be related to the direction of the current in the same manner that the rotation of a nut is related to its retreat or advance upon an ordinary right-handed screw.

GUTTALINE.

A NEW preparation for the purpose of replacing india-rubber and gutta-percha has been brought out and protected by MM. Worms and Zwierchowski. To a quantity of Manila gum tempered with benzine is added 5 per cent. of Auvergne bitumen, also mixed with benzine. These are thoroughly mixed together by mechanical means and by hand. By adding 5 per cent. of rosin oil and allowing 48 to 86 hours to pass between each treatment, a product is obtained having all the suppleness, elasticity, solidity and durability of the best india-rubbers. If the product is too fluid, the addition of 4 per cent. of sulphur dissolved by means of bisulphide of carbon will remedy this. The addition of 5 per cent. of india-rubber to this mixture makes an excellent compound for certain purposes. The vulcanization of this product can be carried out in the usual way.

ELECTRICAL COOKING.

INTERESTING and instructive lectures, says *Industries*, are held in connection with various electrical exhibits at the Crystal Palace. Mr. H. J. Dowsing delivered one on the domestic applications of electricity before a somewhat critical audience recently, in which electric ventilation, electric knife cleaning, electric hat and linen ironing, and electric cooking were shown in practical work. In fact, everything domestic that needs heat, light or power is to be done electrically. The electrical cookery is especially clean and dainty, and is well worthy of inspection.

POINTS ON RAILWAY POWER STATIONS.

BY

Wm Lee Church

[illegible]OT the least marvelous feature of the extraordinary development of electric railway interests, has been the comparative freedom from disastrous mistakes. Looked at from the other side, this is equivalent to saying that street railways have paid from the start. As much as this can hardly be said for any other parallel industry. Electric lighting was notoriously prolific of financial disappointment for many years, and it is only at a comparatively recent date that capitalists have come to understand that electric lighting can profitably be conducted only under the direction of the highest grade of engineering supplemented by close business management. It is undoubtedly true that the experience gained in the exploiting of electric lighting has been turned to account in the development of electric railways, but the marvel still remains that an industry which three years ago was almost unknown, except as a curiosity, should in this short time have attained to a first magnitude among business enterprises, with so little to regret in the way of failure. It is also undoubtedly true, that there are many roads now doing well, which under still better engineering might have done better—and indeed very notably better. Nevertheless, the disposition to let well enough alone, serves as an equalizer of what might otherwise be at least a relative disappointment.

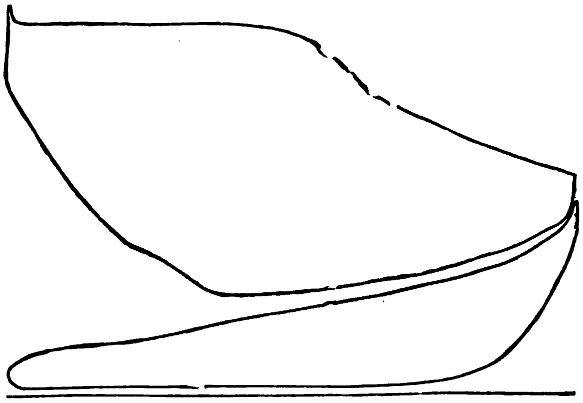


FIG. 1.

It is a narrow mind which will attempt to keep to itself special knowledge on subjects of this nature. The broad education of the public leads through a general increase of intelligence to a greater certainty of success, which, in its turn, redounds directly to the interest of the educator. The writer and his associates have, in the course of events, accumulated certain well-grounded experiences which are of interest to the promoters of electric railways. It is our purpose to give the benefit of this experience as freely as may be to the railway interests at large, and random articles may be expected in the columns of this journal from time to time accordingly.

The subject under consideration at this moment is that of the relative capacity of engines, generators and boilers in the power station. To go at once to the root of the matter, we refer to the diagram which is the chart of ampere readings from a single generator operating an extension line to a cable railway. The generator in question was of the direct coupled, multipolar, slow speed type, popularly known as the "Kodak." Readings were taken at intervals of 15 seconds, and the portion selected for the diagram covers a total time of 21 minutes. While resembling in general appearance similar charts taken from all railway service, it is noticeable that at several points the load entirely vanished for a few seconds. This was due to the fact that but few cars were operated on this extension and the grades were numerous and abrupt in both directions. It would frequently occur that for an instant all cars would be on a down grade, and the circuits entirely open. The most abrupt change is seen to be from 10 amperes to 135 amperes in less than one-half minute. At 4:59 p. m. there was a change from 130 amperes to no load, occurring in three-quarters of a minute. It is worth remarking that under this violent treatment, which is never ceasing throughout the day, the change of speed of the engine and coupled generator could not be noted by any ordinary speed counter. So closely has instantaneous and complete governing been secured through the use of inertia as the governing force, that variation of speed can no longer be detected by the speed indicator and expressed in variations per minute, but must be searched for by the chronograph and expressed in variations per stroke.

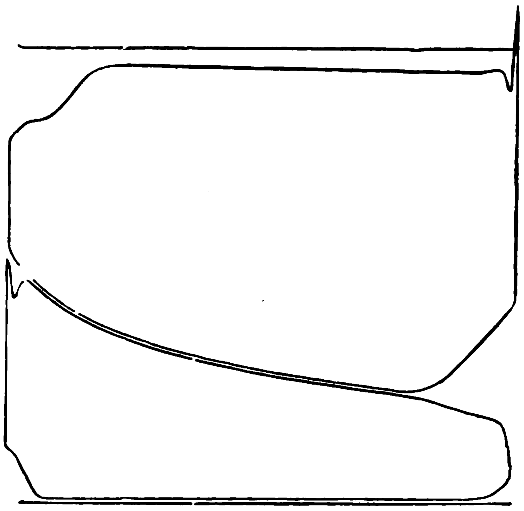


FIG. 2.

Passing to the question of capacity, we will take the generator as the unit of measure. This is moreover the natural unit since the expression for the capacity of a station is in terms of electrical horse powers at the ammeter. In dealing with a problem of this kind, there has sufficient data been accumulated to insure a very close estimate of the nominal amount of generating capacity required to operate a certain number of cars, taking always into account in each special case the grades and curves of the road, nature of the special holiday service, frequency of

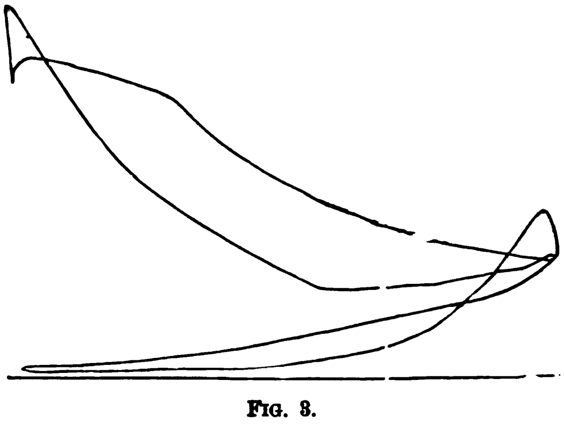


FIG. 3.

stops and other governing considerations. In some respects it would be better if the maximum demand upon the generator could be known, as indicated by the summit of the curve occurring at about 5:06 p. m. on the diagram; but this is, in the nature of the case, hard to determine.

But to facilitate our discussion of the problem, assume that the maximum capacity were known to be 175 amperes, as indicated. We would then locate our nominal generating capacity at some point as indicated by the heavy black line. The reason of this is found in the fact, that an electric generator can stand an overload, or even an excessive overload, provided it does not have to stand it long. The question is simply one of heat. The overload here was seen to continue for only about one minute, during which time the generator could carry it with ease with no perceptible rise of temperature to injure the insulation. If this load had been continuous for an hour or so, as would occur in an electric lighting station, a much higher relative generating capacity would be required, approximating the maximum load.

In this connection it is well to point out that, generally speaking, a long, easy grade is more trying on the generating plant and will call for a greater capacity of the generator, than a short heavy grade. I recall an instance where the lowest point of the road was on a bridge crossing a stream, on either side of which was an abrupt heavy grade for not over 100 yards. Beyond this, the grades were comparatively easy, but persistently up-hill. Although not obvious to the untrained eye, it was the long continued and easy grade which governed the proportioning of the power, and the short grades at the bridge were practically ignored.

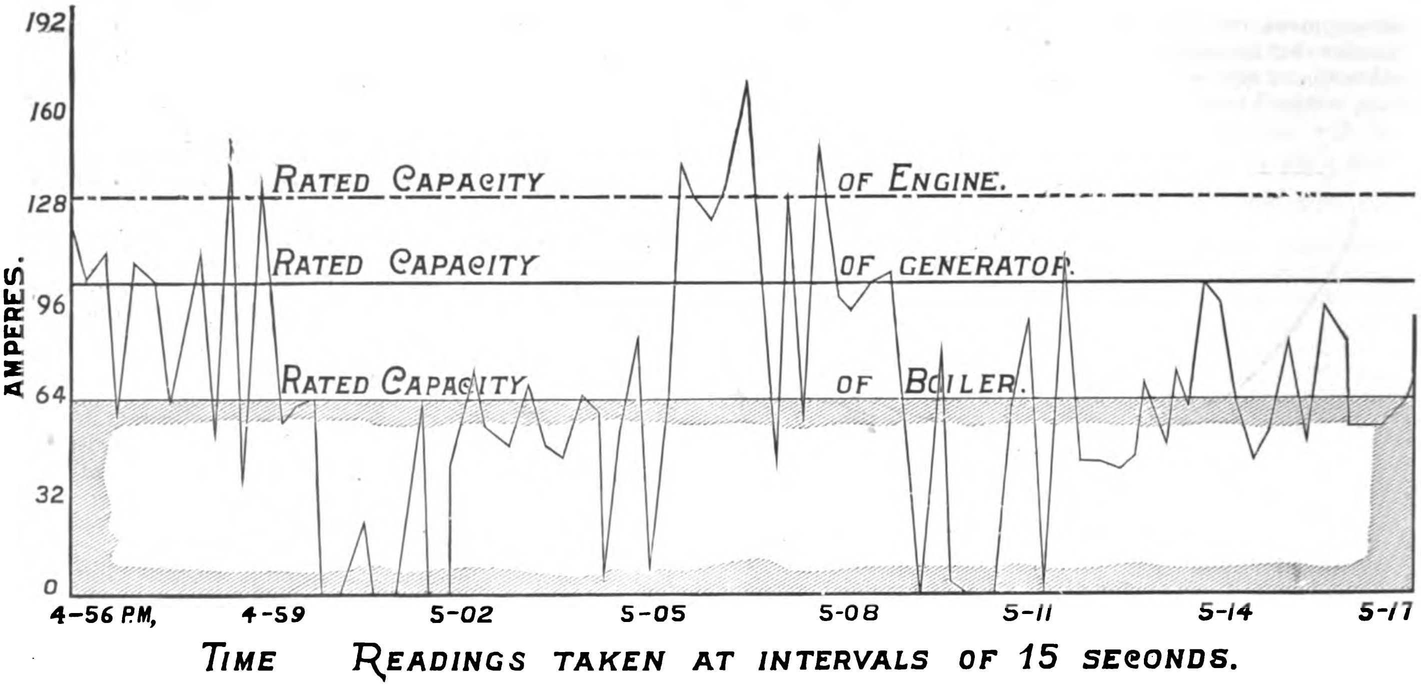


FIG. 4.—AMPERE READINGS FROM A SINGLE ELECTRIC RAILWAY GENERATOR.

Having settled upon the capacity of the generator and located it in the relative position indicated, we next determine the capacity of the connected engine. I am speaking, of course, in this, of power stations in which the generation is in independent units, and I shall undertake to show in subsequent articles what is rapidly becoming established, namely, that a railway station can only reach its minimum capitalization and maximum earning capacity when so designed.

Now, an engine has no such capacity for excessive overload as a generator. In other words, the element of time does not enter into the engine problem, but it becomes a question of how much the engine can actually lift by main strength without taking the governor to an extreme which shall slow down the speed. In general terms, the engine should not be called upon to perform, even for a short time, more than 20 per cent., or possibly 25 per cent., above its rating; we are assuming, of course, that it is honestly rated.

I show herewith three indicator diagrams from a non-condensing compound engine, of which the intermediate size, Fig. 1, indicates about the fair load at which the engine would be rated, and the largest, Fig. 2, shows the ability of such an engine to meet excessive overload. I do not know that I have ever seen this latter card equaled, since it represents 33 per cent. overload with an absolutely perfect distribution of steam, and no loss between cylinders. The smallest card, Fig. 3, indicates the load which might occur a few seconds later in the performance of railway work.

The engine capacity, therefore, must be sized up with reference to the maximum load, and would have a nominal rating greater than that of the generator, being located at some point as indicated by the broken line. It will, of course, be understood that the ability of the valve motion of the engine to take care of momentary overload beyond its own rating is further supplemented by the value of the fly-wheel, although recent practice in connection with the inertia governor, tends towards exacting less from the fly-wheel and more from the steam distribution. The final selection of the engine as to size will depend in every case upon the local conditions of steam pressure as the principal factor.

I will point out further that the capacity of the engine should be determined without reference to condensation. In the vast majority of cases water for condensation cannot be had, and compound engines of this type are now so designed as to yield an almost uniform fuel duty when non-condensing over the full ranges of load that occur in railway service. But even where it is determined to condense, the condenser should still be treated simply as an adjunct of economy, and not as a part of the power. This is for the obvious reason that a condenser may become choked or disabled, or leaky, and the vacuum may be poor, or lost entirely under sudden fluctuations. The engine must by all means be of adequate capacity to walk away with the load without leaning upon its comparatively uncertain assistant. This caution is, by the way, no discredit to condensers, but is simply a necessary consequence of the conditions under which condensers are generally called upon to operate.

We next reach the boiler capacity. It will be obvious that the boiler has to deal only with the *average* of the total load. In the diagram this average is indicated by the shaded rectangle, and is somewhat startling as compared with the apparent power of the remainder of the plant. In this particular, electric railways exactly resemble rolling-mills, saw-mills, and kindred industries, where the load is spasmodic, with variations lasting but a few seconds, or, at most, but a few minutes. The stored heat in the water of a boiler is enormous in quantity, and responds instantly to a release of pressure. That is to say, the boiler is an immense reservoir of power as to volume, and provided the drain upon it is not continued too long, it will stand exactions far beyond its nominal capacity, and without any effect whatever upon the firing. In the earlier stations which we constructed, we did not give sufficient consideration to this fact, which ought to have been obvious. The result was a boiler plant approximately equal to the engine capacity, a large portion of which plant is, perforce, lying idle and unproductive of anything but interest account. Having first encountered this relation as a matter of experience, it did not take long to arrive at the reasons lying back of it, and as a consequence all our stations are now designed with some such proportion of boiler power as is indicated on the diagram.

There has been altogether too much "rule of thumb" in electric railway work, as in other departments of engineering. For instance, "rule of thumb" says, in ordinary mill work, that there should be 20 per cent. more capacity of boiler than of engine. This rule applied without judgment to electric railways, and without considering the characteristics of the engine used, would result in doubling the necessary investment in boilers and in the buildings to accommodate them.

In this discussion I would not be for a moment understood as advocating cheese-paring in the matter of any of the items comprising the generating unit. I am referring only to a question of relative proportion. The intelligent engineer who knows the results of his work are to be interpreted in the light of dollars and cents earned, will follow the excellent advice: "While you are a gittin', git a plenty." The relative proportions, however, will be found very closely as indicated. We would introduce the caution that a relay boiler should always exist in every station. A large station will carry a relay unit throughout, but even a moderate station should show one relay boiler and a relay feed pump. The engine and dynamo can be fairly trusted to take care of themselves, since any ordinary repairing can be quickly made between running hours. Not so with the boiler, which is liable to occasional repairing or cleaning that will throw it out of service for one or more days, and this is not thinkable in connection with street railways.

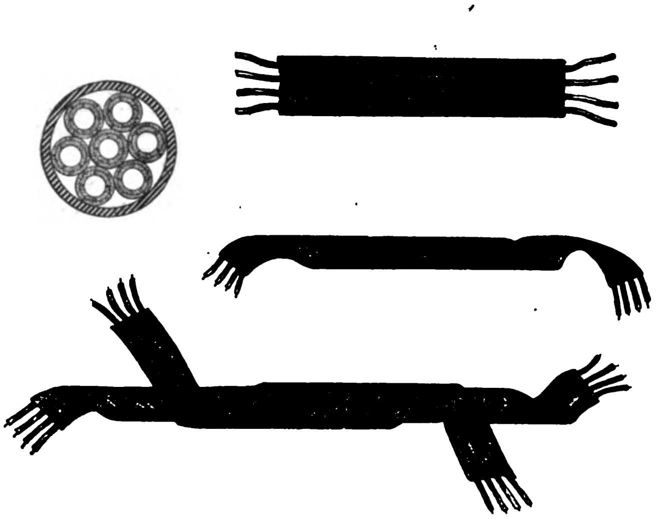
The actual size of the boiler will, of course, depend upon the type of engine used. With the compound engine above described, making such diagrams as are here shown, and running non-condensing, an allowance of 30 lbs. of water actually evaporated for each indicated horse power will give abundant margin for all contingencies. It must be borne in mind that the duty under an average uniform load is a very different thing from the duty under a variable load represented by the average. Under the uniform load, 23 lbs. of water would be the actual engine performance, and the boiler could be proportioned with reference to this figure. Under the violent fluctuations of railway service, the average duty of the engine will rise to about 28 lbs., and if the maximum average load is taken, and the boiler proportioned for 30 lbs., there will be a sufficient margin.

These remarks apply only to the particular type of engine under discussion, as other compound engines not possessing the feature which secures uniformity of duty, will range up to at least 45 lbs. under light loads, and often to 60 lbs., and represent an average duty not better than 35 to 40 lbs. The same is true of every form of non-compounded engine, whether high speed or low speed, both of which show a tremendous falling back of fuel duty under variable load. But in the language of Rudyard Kipling "That is another story," and is worth another article.

THE SAWYER TELEPHONE CABLE.

In order to produce a cable for telegraph and telephone work having low inductive capacity and high insulation, and which, at the same time should be light, flexible and inexpensive, Mr. William H Sawyer, of the American Electrical Works, Providence, R. I., has recently devised the arrangement shown in the accompanying illustration.

In Mr. Sawyer's cable a number of insulated conductors *a*, usually four in number, are braided or woven at regular distances apart with some fibrous material into a continuous flat ribbon, which is then twisted or wound into a spiral tube A, leaving a central air-space. The conductors are so woven with the fibrous material as to form an open-mesh work between the wires, and when the ribbon is twisted into a helical form the wires are all approximately equidistant, thus securing the lowest inductive capacity between them. Upon the spiral tube thus formed is wound a second ribbon, similar to the first, but wound in a reverse direction; thus securing the greatest separation of conductors within the least possible space.



SAWYER TELEPHONE CABLE.

In forming the complete cable a number of sections thus constructed are grouped together and inclosed in a lead sheath, or a series of successive ribbons carrying the braided wires may be wound upon the spiral tube A until the cable is built up to the desired diameter and then inclosed in a lead sheath, each ribbon being wound in a reverse direction to that of the underlying section.

A DASTARDLY ACT.

During the little excursion given by the Ford-Washburn Storelectro Company to the members of the Toronto city government on their storage battery car last week, there was a singular episode, to state it mildly. Towards the end of the trip it was discovered that some one had joined the wires on the rear end, used for connecting the battery with the meters, in such a way as to short-circuit the whole battery! This occurred when Mr. Washburn and his assistant were in front driving the car. The Washburn battery, however, was uninjured. The evident object of this dastardly act was to hamper the running of the car, but it had no appreciable effect upon it, and was therefore an unwitting advertisement in its favor of the highest value.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 203 *Broadway, New York City.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

Advertisements.—*We can entertain no proposition to publish anything for pay, or in consideration of advertising patronage, except in our advertising columns Our editorial columns will express our own opinions only, and we shall present in other columns only such matter as we consider of interest or value to our readers.*

VOL. XIII. NEW YORK, APRIL 27, 1892. No. 208.

> ***Every student is surprised to find how very little is the share of new truth which even the greatest genius has added to the previous stock.—Josiah Parsons Cooke.***

REMOVAL NOTICE.

THE ELECTRICAL ENGINEER will remove its office, April 27, to the fine new *Mail and Express* building, Broadway and Fulton Street.

The address will be

203 Broadway.

The new quarters are not only more spacious and commodious than the rooms occupied during the past two years, but are better adapted in location and in facilities for conducting business and receiving visitors. The site is in close proximity to the Post Office and the Astor House, and but a door from the Western Union headquarters.

203 Broadway.

STORAGE BATTERIES IN CENTRAL STATION WORK.

THE rush into alternating current work in this country has been so great that many electrical engineers have lost sight of the fact that the use of such currents is only one way of distributing electrical energy for light, and not the one only way. This headlong adoption of a new thing is characteristically American, and so often leads us forward to better things that it may be forgiven when it sometimes blinds us to the advantages still to be found in other methods suffering from neglect. In this instance, if we may judge by reports reaching us from across the Atlantic, no small injustice has been done the storage battery in the distribution of electricity. Indeed should these reports be but half true, the storage battery has entered upon a period of rehabilitation very much like that of the prodigal who wasted his substance and other people's in riotous living and then settled down to hard work and fat veal. That use should be made of the battery in central stations is not surprising; on the contrary, the wonder is that to-day in this country, so far as we are aware, not a single central station employs storage cells as an auxiliary in the supply of current.

In a recent work on continental central stations, based upon a German volume of official reports already reviewed in these pages, Mr. Killingworth Hedges gives a list of stations in which batteries are a valuable adjunct. Most of the plants are small; but some of them are of quite respectable size. They run as follows: Barmen, 5,000 lamps of 16 c. p.; Hanover, 30,000; Düsseldorüf, 20,000; Dessau, 2,500; Rheims, 540, Berlin, 800; Bad Kösen, 600; Gevelsberg, 2,000; Bamberg, 2,700; Darmstadt, 5,800; Paris, 19,500; Gablonz, 1,500; Konigsberg, 1,600; Blankenburg, 1,000; Berlin (Hospital) 2,000; Vienna, 10,000. To this list might be added, we believe, Salzburg, Lyons, Toulon, Montpellier, Mulhausen, Stockholm. Sundsvall, Munchen-Schwabing, Varese, Susa, Bremen, Breslau and Stettin, although few details are given with regard to these; while it appears that batteries are to be added to the Hamburg central station which operates 12,000 lights; Wildbad-Gastein, 1,200; Elberfeld, 14,000; Arco, 2,500. It is not to be understood from this list that the equipment of batteries is in any instance equal to the number of lamps named; but in several cases the figures are large. Barmen, it seems, has four double sets of batteries, 68 cells each, and is now going to erect five sub-stations which will be charged during the day by the main central station. We do not think this sub-station plan has had any trial here since that of half a dozen years ago at Cheyenne, Wyo., and at Germantown, Pa. At Hanover, the accumulators are placed on four floors, each battery consisting of 136 cells of 1,320 ampere hour capacity, and a discharge of 396 amperes. The Düsseldorf plant is already running three battery sub-stations; the largest has two batteries of 140 cells, each with a discharge of 483 amperes, while the other two with an equal number of smaller cells discharge 248 amperes. An interesting feature of the Dessau installation is the employment of gas engines as primary power. It is stated that the addition of accumulators of 1,700 ampere hour capacity to this plant increased the investment 15 per cent, and raised the output

38 per cent. The present batteries have been in use uninterruptedly for nearly two years without attention, so it is asserted, and more than once have been called upon for an output 20 to 25 per cent. above the normal.

Evidently we must deal with a condition rather than a theory. If all these various plants in Europe, with different batteries and generators, find it profitable to operate in this way, surely there is opportunity for similar methods in America. We have been informed that the tendency abroad is in the direction of using much larger cells than anything yet known here, and the idea strikes us as eminently shrewd and feasible. Why not try it here?

NON-ARCING METALS.

Now that the broad lines of electrical engineering are fairly well established and the profession has attracted to it many young men well grounded in theory, we find frequent instances of extended research and investigation with the object of improving the details of existing apparatus. Prominent among these studies, of late, has been that of the lightning arrester, new examples of which, based on a variety of principles, have from time to time been described in our columns. One of the most original communications on this subject was, without doubt, the recent Institute paper of Mr. A. J. Wurts, in which he demonstrated the peculiar non-arcing properties of certain metals which thus fitted them specially as materials for the construction of terminals between which arcing is likely to occur. Mr. Wurts' original theory explained the action observed, by the assumption of a non-conducting oxide formed by the arc, while in a recent issue Mr. R. G. Fessenden, as the result of experiment, inclined to the pure metallic vapor theory. In this issue Mr. Wurts returns to the subject, bringing to his assistance that powerful aid to modern research, photography, and showing in a striking manner the great reduction in the violence of the arc as encountered with the usual terminals. These photographs are also of no little interest as bearing upon the fact, now pointed out by Mr. Wurts, that all of the non-arcing metals thus far investigated are diamagnetic, a circumstance which throws some light on the repulsive action in the arcs shown in the photographs. The reduction of the arc with the reduction of the air-gap might be explained on the assumption that the reduced gap is jumped by a lower accumulated potential and hence one less violent in its action.

ELEMENTARY ELECTRO-DYNAMICS.

We began in our last issue the publication of a series of articles on "The Theoretical Elements of Electro-Dynamic Machinery," from the pen of Mr. A. E. Kennelly, to which we would draw special attention on account of the method of treatment adopted by the author. Notwithstanding the works already extant, we agree with Mr. Kennelly that there is room for a particular line of technical literature bearing upon electromagnetic machinery; not the purely scientific treatment of Maxwell, and his followers, nor the path of practical description of machinery, both these aspects of the very wide subject having already been well treated. We refer to what might be called applied theory. That is to say, there would be fewer badly designed motors and abortive transformers, if the fundamental principles of their theory were more generally grasped. There are many good motors and transformers, but their excellences are often caviare to a multitude of their operators for similar reasons. The theory of their electrical behavior is often hidden under a pyramid of symbols, and it seems frequently that the purposes of mathematics would be better served by a little less brevity and a little more verbiage, in specific applications to the work of those who are not long trained to their manipulation. The series of articles that would reach the actual workers must be quantitative essentially in their treatment, and must therefore be mathematical, but the reasoning can be brought within the grasp of all students of average powers, by proper treatment. We feel convinced that a great demand exists for such a course of literature. For, have we not all often pored long over some mystic statement in well-known tomes that a turn of the wrist would have made so easy? Nature is always easy, and difficulties arise from the superposition of many simplicities that mutually conceal.

Mr. Kennelly will lead up from the theory of electromagnetism, so far as it is practically essential, to the principles of electrical design—not mechanical design—in the leading forms of simple magnetic machinery.

POINTS ON RAILWAY POWER STATIONS.

Considering the comparatively short time during which electric railways have come into operation, it must, indeed, be a subject for congratulation that electric railways are paying and paying well, even those roads that were among the first to take up this mode of traction. While admitting this, Mr. Wm. Lee Church very truly remarks that, notwithstanding the success in electric railroading, improved methods of power station construction and equipments might well be adopted in many cases. He proceeds to demonstrate, in this issue, just in what way the highest economy can be obtained. He has taken up the important question of the proportions between the generator, the steam engine and the boiler capacity, a subject which will be admitted to be of the highest importance. Mr. Church bases his arguments on the premises that both the boiler and the electric generator are capable of carrying a considerable overload with safety for short intervals of time, while the engine on the other hand is less able to stand overloading in the same way. These are points which we have not seen brought out in this way before, and they deserve the closest attention and scrutiny of all electric railway managers.

Mechanical Strength of Dynamos and Motors.

In the series of articles on the practical management of dynamos and motors, Messrs. Crocker and Wheeler discuss this week a question which is too often lost sight of but which is entitled to the most serious consideration. Mechanical strength, especially in moving parts of the dynamo-electric machinery, is of the highest importance, the more so as these machines are subjected to stresses, as in the case of the armature, which are usually not taken into consideration. While it is desirable to prevent waste of material, it is always well to be on the safe side, and a little extra metal in the right place may avoid much vexatious repairing later on.

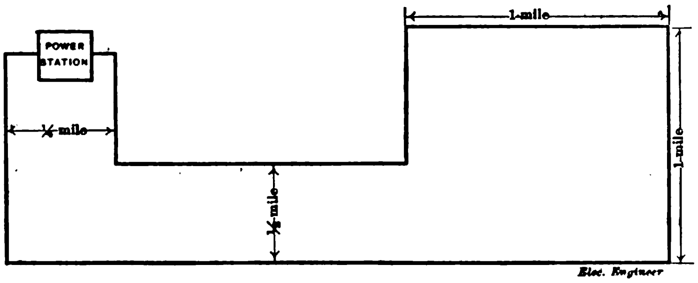
ECONOMY IN ARC LIGHT WIRING.

BY

H. B. Rommel

In taking exception to my discussion of his paper on "Economy in Arc Light Wiring," Mr. Sharpsteen still labors under the delusion that all of our towns in which plants of from 50 to 80 lamps are in operation are necessarily densely populated and have but two or three streets which run parallel to each other, and very close together. Under these favorable circumstances, I admit the value of the proposed system of wiring; but unluckily for the engineers in charge of such construction work, they do not often meet with such a favorable arrangement. It is true that the majority of such towns have but two or three business streets but not often located to advantage.

I give below a sketch of the business streets of one of these towns, where I was called upon to construct an arc circuit for 50 lights. About twenty of these were street lights and the remainder commercials. It was necessary for us to have the line on every street shown, and to loop from one street to the other, in order to keep the commercials (which were about evenly divided) in rotation, we certainly would have consumed at least as much, if not more, wire by Mr. Sharpsteen's method than by running two complete circuits, and a great many more poles, which it would be necessary to place on side streets where they would be of no benefit for the use of other wires. It must be remembered that the original cost of poles and setting enters into consideration as a matter of economy, as well as the amount of wire consumed.



A METHOD OF ARC LIGHT WIRING.

I by no means lose sight of the fact that the line can leave the main street and return several blocks below or above; but it is doubtful if this is advisable, as electric light superintendents are well aware of the fact of the instability of commercial arc lights in our smaller towns; these lamps often being in service but several months, when they are removed to another customer. If the plan in question is followed, the poles and wire constituting the loop for this lamp are a dead loss, unless a consumer be found near the same place, and the advantage of having the line the entire length of these streets, when a possible future customer can be immediately given service, is easily seen. The continual planting of poles and stringing of loops under the proposed plan is by no means inexpensive, and will often amount to more than the possible saving in wire. This system of wiring certainly has its value in some instances, but it should by no means be considered as a standard for all of our smaller towns.

Mr. Sharpsteen requests that I mention the arc lamp of which I said the excess current passing through the magnet coils after the point of cut-out has been reached was detrimental to the coils and adjustment of the lamp. The lamp in question was the Thomson-Houston, which is no doubt more extensively used than any other in this country to-day. Any person familiar with this lamp will appreciate the difficulty experienced by allowing the lamp to cut itself out as mentioned; and will see the necessity of a short-circuiting switch, or some similar device, for the safety and good adjustment of their lamps, which, in other words, means economy and satisfactory service.

METHODS OF ELECTRICALLY CONTROLLING STREET CAR MOTORS.[1]

BY H. F. PARSHALL.

While in many respects the controlling apparatus for street car motors and the general requirements of the same do not differ greatly from some other cases, there are some features that demand the closest attention if the car is to be handled either efficiently or comfortably so far as the passengers are concerned. While the number of methods proposed and tried in times past has been great, at the present time there seems to be sufficient agreement between the principal designers and sufficient data at hand to warrant the writing of a fairly comprehensive paper on the subject.

The problem of controlling the motors is probably the most difficult one in the whole range of street car work, and in no small degree determines the electrical design of the motors, or, to be more specific, to start a car under any given conditions of track a certain torque is required. Beyond a certain limit, fixed largely by the convenience of passengers, this torque cannot be exceeded. The smaller the current with which the motor is able to develop this torque, the smaller the rheostat or other starting devices may be and the more efficient the car equipment. Should the motor, therefore, be incapable of developing a comparatively powerful torque per ampere, the amount of energy dissipated either in the magnetic windings, armature windings, or rheostat becomes excessive, the results being the more or less rapid deterioration of these parts.

It may not be out of order just here to discuss the design of the motor with reference to getting this torque most efficiently. The average h. p. exerted by a street car motor at the car wheel probably does not exceed 20 per cent. of the maximum it is expected to do in starting the car under the various conditions encountered. Now to get the highest efficiency from a motor run under these conditions, it is necessary to get the highest possible efficiency at that h. p. at which the greatest amount of work is to be done, and inasmuch as the loss in the conductors for this average h. p. is necessarily low (otherwise the motors would burn out in doing the maximum work to which they are subjected), the question does not resolve itself into how to get the least possible motor resistance of armature and magnets, but rather, how to minimize the constant loss of hysteresis, eddy currents and friction. While all of these losses vary somewhat with the speed in series-wound motors, the variation of these losses is not great, since for an increased speed there is in general a diminished intensity of magnetization and pressure. To render these losses a minimum, and at the same time to get the requisite torque to handle the car efficiently, there is but one solution, that is, to put the maximum number of turns on the armature compatible with good running as to heating and sparking.

While the truth of these statements may be more or less apparent to all when stated in plain terms, but little attention was paid to this matter in the earlier motors designed. The numerous measurements made, however, have so uniformly been in favor of motors with comparatively a large number of conductors on the armatures, that the importance of this matter is now pretty generally understood. This agreement as to the general design of motors has in no small way been influential in bringing electricians into agreement as to how the motor should be controlled, since with an armature of a comparatively large number of turns, less turns are required in the field magnets to produce a given torque with a given number of amperes. The function of the magnets, therefore, has become of less importance. It is always, however, to be borne in mind that, other things being equal, the motor with the greatest number of turns in the magnets will develop the greatest torque for small currents. With a given E. M. F. acting on the armature circuit, and a given torque developed by the armature per ampere, it does not matter, so far as efficiency is concerned, whether the difference in E. M. F. at the armature terminals and the line is due to drop in external resistance, or to drop in the magnets. This point determines once for all, that motors with commutated fields are not necessarily more efficient than other motors.

The particular advantages of the commutated field method are, that with a limited number of pounds of copper, or in the case of street car motors, with the limited space available for field magnet windings, it is possible to adjust the magnetizing force of the field coils so that the rate of doing work of the motors may be made to correspond with the rate this work is required by the car for the various speeds and conditions of track. This adjustment may be made for any size of motor with any required degree of precision by varying the number of magnetic coils. To increase the range of precision it is only necessary to increase the number of coils. In practice it has been found that this number could not be very great, otherwise the car wiring becomes too complicated and too expensive. This same holds true of the controlling switch. Three magnet coils or sets of magnet coils seem to be the practical limit, since there is a general agreement between street railway managers that the present number of magnet connections (6) should not be increased, and even with this number there is occasional trouble with broken wires or terminals. With a 15 h. p. motor it is possible with three sets of coils to run under most conditions met with in practice without employing external resistance. It is occasionally necessary, however, when the car is to be run at two or three miles an hour, to make use of the resistance coil that is ordinarily used only when starting. With 25 h. p. motors it is necessary, with three sets of magnet windings, to make use of this resistance coil very considerably in ordinary practice, since without this it is not possible to get a speed of less than one-third the maximum speed of the car, which is generally taken to be about 18 miles an hour.

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[1] A paper read before the American Institute of Electrical Engineers, New York, April 19, 1892.

EFFICIENCY OF STREET CAR MOTOR NO. 6.

Brake H. P.	Efficiency.	Speed.	Remarks.	Res.
14.3	87 per cent.	1110	3 coils in parallel........	0.8
11.8	87 "	1174	3 " "	.8
11.4	86 "	1184	2 " "	1.4
9	84 "	1309	2 " "	1.4
8.25	82 "	955	2 in parallel, 1 in series..	3.24
6.35	79 "	1040	2 " 1 " ..	3.24
4.9	72 "	1070	2 coils in series..........	4.86
3.9	70 "	1014	3 " "	7.42

The range of speeds without the use of a rheostat is determined by the limit to which it is safe to heat the magnets. The temperature of the magnets should not in any case exceed 65° C. This would put the increase of temperature at about 30° C. This increase corresponds to an average loss in the magnets of about 0.3 of a watt per square inch of radiating surface. For the few seconds generally taken to start the car the loss may be as high as two watts per square inch without dangerous heating. Experience, however, has demonstrated that to exceed this limit, even for very short periods, there is considerable risk. Having the maximum number of watts that may be dissipated in the magnets, the series resistance of same may be calculated from the properties of the motor on the supposition that each ampere taken by the motor produces a certain number of pounds pull at the periphery of the car wheel. In a well-designed motor with commutated fields it is easy to get from 35 to 40 pounds pull at the periphery of a 30″ car wheel with the coils in the series position. These coils are either wound side by side, or one on top of the other, according to the necessities of the case as determined by the general design of the motor. Experience has shown the advisability of winding these coils in independent spools whenever the general design will permit, since in case of trouble it is cheaper and easier to replace the damaged coil, and there is less liability of crosses between the coils. As an example of a design, that has been found to give general satisfaction in practice, I give the figures in the table from a series of tests made on a Sprague No. 6, S. C. Motor, the magnetic data of which has already been published by myself.[1]

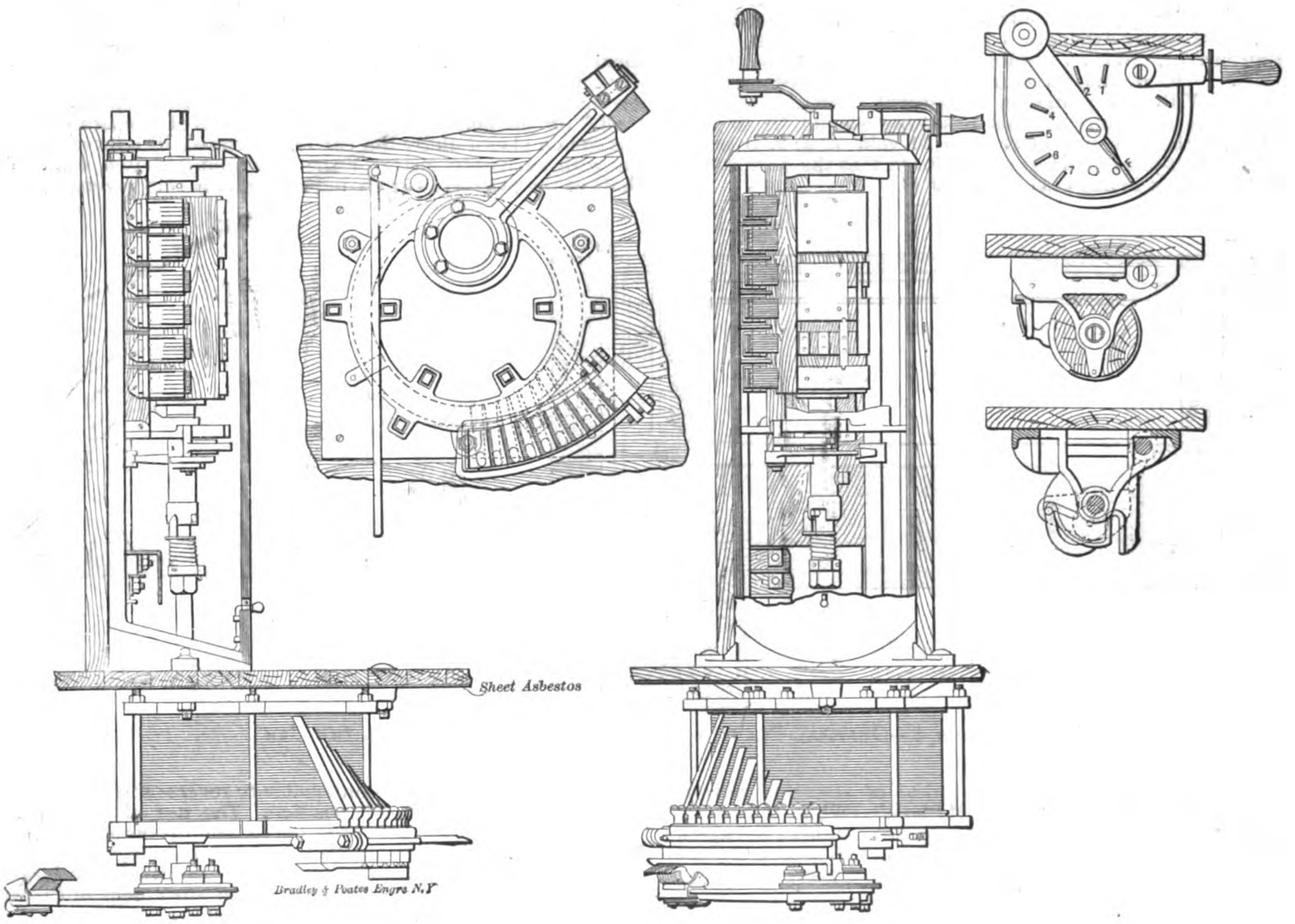

FIG. 1.—PLATFORM SWITCH ARRANGED FOR SERIES-PARALLEL SYSTEM OF CONTROL.

It is to be noted especially that it is possible to get an approximately constant speed with a wide range of loads, and yet have the energy dissipated in the magnets remain approximately constant, and that it is possible to get a torque corresponding very approximately over a wide range, to that required to propel a car under conditions met with. This is the solution of the question, How to get the highest efficiency. For instance, suppose a car is to be run between two points in a given space of time, and this is not an unfrequent requirement, and that the magnet windings of the motor are such that either the car runs the distance in too short a time or in too long a time; it will be necessary then to accelerate the car for a time beyond the limit required, then to allow it to slow down, then to accelerate it again, or go through some such cycle of operations to get the required results. More power will be required with such windings than when such a torque can be had at the motor, that will produce the required speed by an approximately uniform acceleration. To get the same results given above for the No. 6 motor, with the magnet coils arranged in loops instead of separate coils would require upwards of three times as many pounds of copper as was used in the present case (110 lbs.) This motor was designed to give a maximum car speed under ordinary conditions of from 12 to 15 miles an hour. At present it is thought advisable to have a maximum car speed of from 18 to 20 miles an hour,[1] since numerous measurements have shown the economy of running street cars at as high a speed as the conditions of track, etc., will permit. In a series of measurements made by myself, it was found that the watt hours per car mile decreased very considerably with the speed of the car up to 30 miles an hour. To get this high speed, (20 miles per hour) it has been found necessary to vary the proportions of the magnet coils from that given in the above for the No. 6 motor. Thus for a single-reduction 15 h. p. motor the resistance of the last coil to be turned from series to parallel is only 15 per cent. of the total resistance of the magnets, and the turns of this coil only 20 per cent of the turns in the other two coils. The reason for putting this low resistance coil inside, is to get the greatest number of turns when the coils are all in series and the least resistance when the coils are all in parallel. Further, under ordinary conditions this coil has the least expenditure of energy in it, and the least radiating surface. With a winding of this proportion, it is necessary with 15 h. p. motors to use an external resistance of 6 or 8 ohms. With 25 h. p. motors an external resistance of from 10 to 12 ohms is required. This resistance should be so subdivided that there is not more than 20 volts E. M. F. between adjacent contact-pieces, and so proportioned that the increase of temperature is not in any case above 150° C.

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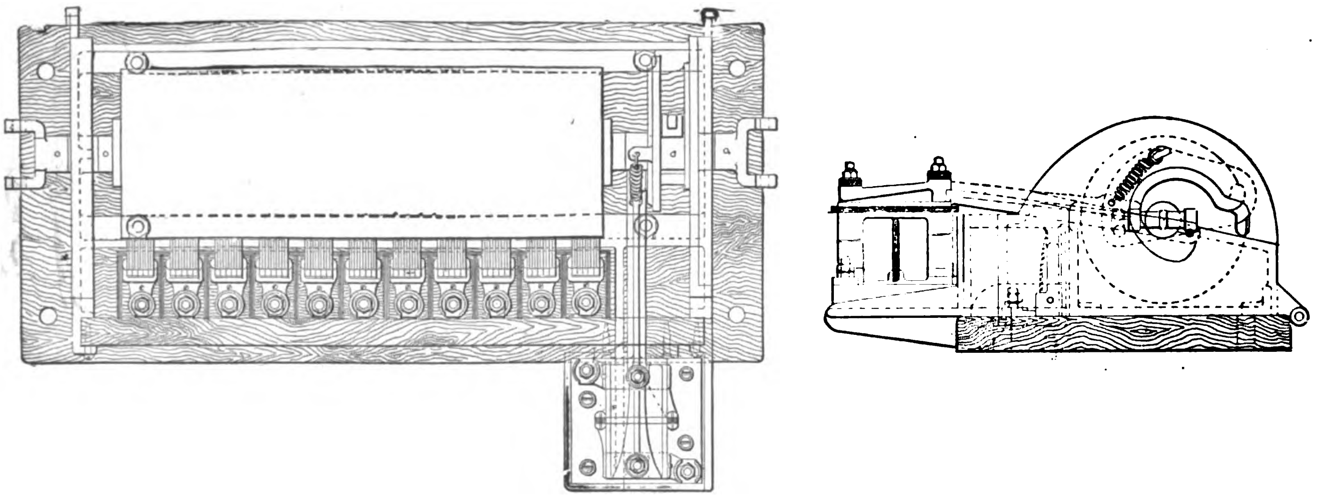
[1] Transactions, Vol. VII, p. 218.



FIGS. 3 AND 4.—GENERAL PLANS OF SWITCH WHEN PLACED UNDER THE CAR.

A method that is receiving a great deal of attention now is that known as the "Series Parallel Method." While it has not yet been introduced very largely in practice, numerous experiments have indicated the desirability of doing this as soon as some of the troublesome features of the switch have been overcome. The method of operating is as follows:

In starting, a rheostat of from 8 to 20 ohms is used, according to circumstances, in series with the motors, which are in series with each other. After this resistance is thrown out of circuit the magnet coils of one of the motors are short-circuited, a section at a time. To make the start smooth, three or four coils at least are required. The magnet coils being short-circuited, the armature is then short-circuited, and the magnet coils thrown in circuit simultaneously with the armatures being thrown in parallel. It is just at this point where the difficulty with the switch has been encountered, since either the switch has to be operated with great rapidity or the contacts act in perfect unison; otherwise unpleasant results as to short-circuiting occur.

The advantages of the method are that a very wide range of speeds are obtainable at a comparatively high efficiency, and that the energy required to be dissipated by the rheostat is small for the low speeds frequently required in city practice. This lessening the duty of the rheostat is a very important point, since as yet it has been found exceedingly difficult to construct a cheap rheostat that could be placed under the car in the small space available and dissipate so large an amount of energy as is required when the car is to be run for a considerable time at a speed as low as two or three miles an hour. Any method of control that has lessened the energy to be dissipated in the rheostat has in general been considered with favor, since there has been a corresponding diminution of trouble in each case that the energy to be dissipated has been lessened.

Having now given a general discussion of the problem a brief description of some of the apparatus recently devised may prove of interest.

Fig. 1 shows the general design and arrangement of an improved form of platform switch, which combines both the "field commutation" and the "series resistance" methods of starting cars. To start the car, the switch handle is turned from the position marked "off" with a counter-clockwise movement; this movement carries the arm of the rheostat, which is placed under the switch, around and over the contact segments, so that the resistance is gradually cut out of circuit. After the contact arm has been carried around to 135 degrees and all the resistance has been cut out, it is released from the cylinder shaft and left locked in this position. A further movement of the switch handle then affects only the cylinder, and commutates the sectional windings of the field magnets of the motor from series to parallel in the usual way. In stopping the car the field coils are turned from parallel to series, the resistance coil is then again put into circuit and the circuit broken when the contact lever leaves the last segment of the resistance coil, and not, as hitherto, upon the cylinder contacts. The only caution to be observed in stopping is to see that the switch handle shall be turned to the position marked "off," for the motors are reversed by means of a separate reversing switch placed under the car and operated by a lever connecting with a separate shaft in the controlling switch case. The shaft of the platform switch interlocks with this reversing shaft in such a manner that it is impossible to reverse the motors until the cylinder is in the "off" position. The use of this separate controlling switch has been objected to, but to combine both the advantages of the rheostat and commutated fields the switch mechanism becomes too complicated and the switch too large to have the reversing performed by a reverse movement of the controlling switch handle.

The cylinder plates and contacts are made of thick iron stampings, as experience has shown that iron is more durable than brass for this purpose. The burning, due to the formation of arcs, does not have so much effect upon iron as it does upon brass, and there is more certainty of good contact. The contacts on the cylinder consist of a number of stampings arranged in a brass frame, each stamping making an independent spring contact with the switch cylinder. The rheostat employed is built up in a circular form from a large number of flat rings stamped from thin iron sheets. The rings are built up in the form of a cylinder, each ring of iron being separated from the adjacent rings by a ring of mica, except at the point where it makes contact with the ring on the other side of it. Instead, however, of being arranged in a continuous spiral circuit, the coil is divided into a number of parts so arranged that the direction of rotation of the adjacent spirals is reversed, this being done to make the inductance of the coil as small as possible. A coil wound up in a continuous spiral having a mean diameter of 12″ and a radial depth of 1″, 6″ long, and composed of 400 plates, was found to have an inductance of 40 milli-henrys. The coil was then wound up in 12 sections, the direction of each section being reversed, and the inductance in this case was found to be 8.5 milli-henrys. These sections are stamped from different thicknesses of metal, so that those coils which are in circuit the shortest time and have the least current to carry are of highest resistance and least ampere capacity, and those that are liable to be in circuit for some time are thicker and have less resistance and greater ampere capacity. Copper connections are made at different points in the coil, all these connections being brought to a number of small iron contact pieces fitted in a spiral form and arranged so that the switch contact lever can slide over them. The contact pieces are insulated from the frame with sheet mica and from one another with small slate slabs. The rheostat is entirely fireproof and can expel with safety the heat evolved within it under all ordinary conditions. As a point of practical importance it is, however, advisable to place a sheet of metal and a layer of asbestos paper between the rheostat frame and the car floor. This will prevent any danger from fire, either from heating or sparking, should such occur. It is to be noted that the general design of this rheostat is such that those parts having mechanical functions and energy-dissipating functions have been separated as much as possible. Of course the mechanical functions of a rheostat are more or less limited; it is evident, however, this effort is in the right direction. It is with respect to this particular point that the rheostat has a decided advantage over any form of mechanical clutch in starting a car. The clutch, of course, has its advantage in starting quickly bodies that have a great amount of inertia. In ordinary practice, however, the amount of energy dissipated in a clutch is approximately equal to that necessary to dissipate in a rheostat, but the clutch has in addition to its energy-dissipating function, a very exact mechanical function, and these two functions are interdependent on the same wearing parts. For this reason, if no other, clutches have not yet been made to compete favorably with rheostats.

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[1] All car speeds are quoted for straight and level tracks. These when calculated for a new motor are determined from the speed and horse power curve of the motor, assuming the resistance to be 30 lbs. per ton. The methods of measuring these speeds are in general such, that the probable error is too great to determine the percentage slip of the wheels.

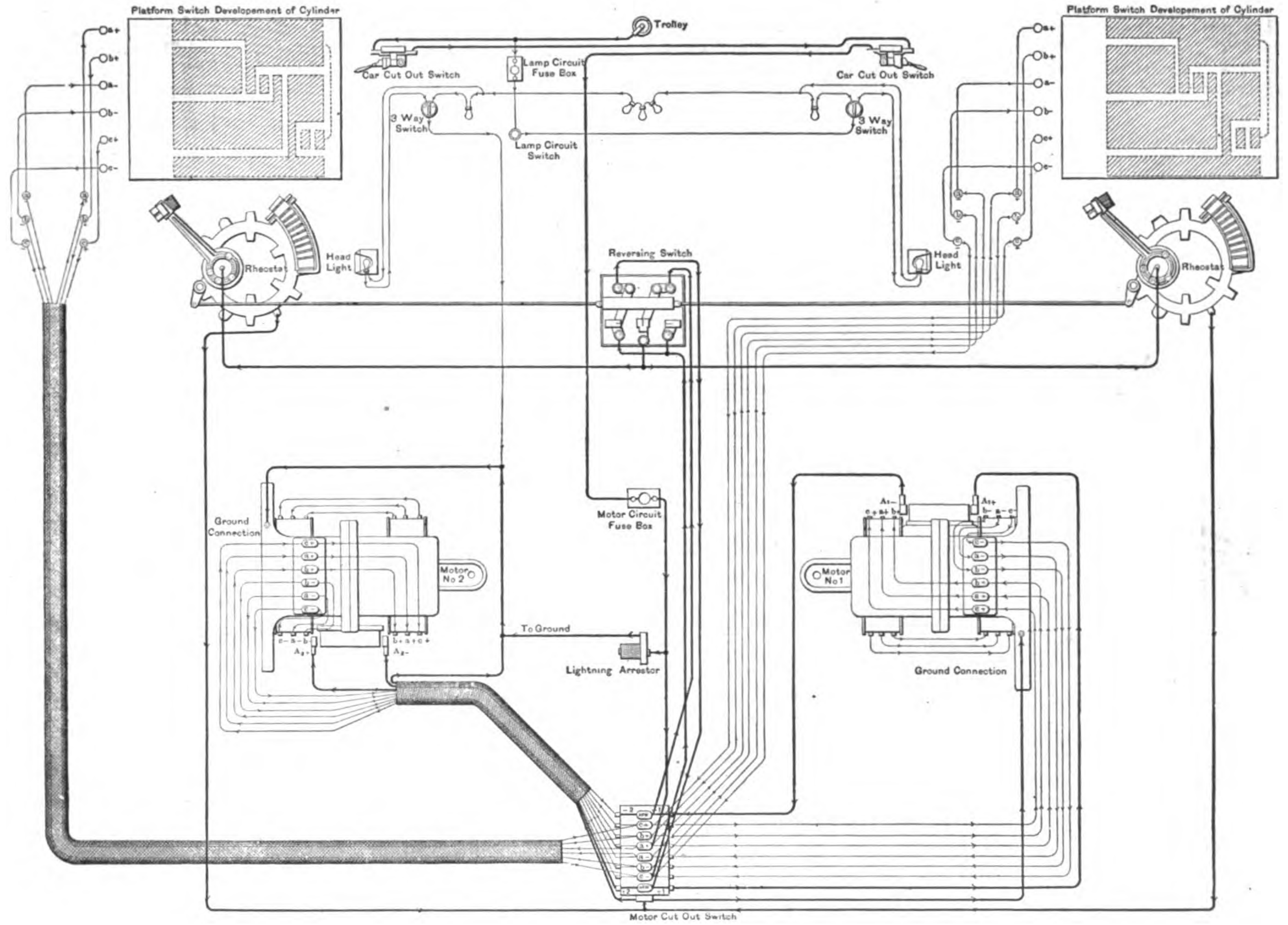


FIG.—DIAGRAM OF CAR CONNECTIONS FOR SERIES–PARALLEL SWITCH.

Fig. 2 gives a diagram of the car connections for this switch. It will be seen that the current from the trolley wire first goes through the field coils and switch cylinder for commutation, then through the armature and reversing switch, and thence through the switch contact lever and resistance coil (in starting) to ground. It will be noticed that by use of the separate reversing switch the armature wires and field wires are each kept separate and distinct from one another. Formerly there was considerable trouble from the breaking of these wires, especially where the wire entered the brass terminals at the various terminal boards. This has been almost entirely obviated by using 49-strand cable wherever wire was subjected to bending.

In some cases the construction at the platform ends is such as to make it inconvenient to place the rheostat used with this form of switch immediately underneath the cylinder. This is the case when certain kinds of draw-bar or step constructions are used. In these cases a modification of the switch arrangements is made so that instead of the rheostat a light frame is placed directly under the cylinder. This frame serves to support the switch shaft, upon which is placed a crank connecting with a bar, which is carried off to the rheostat contact lever. With this arrangement the rheostat can be placed under any convenient part of the car flooring and operated as well as when directly under the platform.

Figs. 3 and 4 show general plans of a car switch designed to be placed under the car and about half way between the motors, when the car construction permits. This design, while open to the criticism that the switch is somewhat inaccessible for inspection, meets the demand that has sometimes been made when it has been thought the space ordinarily occupied by the platform switch could not be sacrificed. The principle is the same as the platform switch already described, but it is modified in form and shape to suit the particular condition under which it is to work, and it is to be noted that the mechanical adjustments required are much more exact, otherwise there would be considerable burning of the contacts, since the motorman would be unable to tell whether or not the switch contacts were on proper positions. The rheostat is arranged in sections and connections brought from them directly to cylinder contacts. A cylinder is used to commutate both resistance and field magnet coils.

An important point that has been attended to in this switch is the breaking of the circuit on a separate switch instead of on the cylinder. A snap switch, of the knife blade pattern, is employed to break the circuit at four points. It operates in connection with the cylinder shaft, to which it is connected with a special locking and releasing gear of similar design to that shown in Fig. 1. The first movement of the cylinder shaft closes the snap switch and completes the circuit through the coil. Further movement then disengages the snap switch from the shaft (leaving it closed) and the different commutations are effected. When breaking the circuit the snap switch is again brought into action.

When this form of car-controlling switch is used, the platform lever is fitted at its lower end with a bevel gear wheel meshed into another gear wheel placed on the cylinder shaft. When necessary an extension shaft fitted with one or more universal joints makes connection between the platform lever and the cylinder shaft. When this switch is placed in the middle of the car, the amount of car wiring is materially lessened and the car inspection made more easy.

With reference to controlling switches in general, it is evident that a great number of designs may be prepared that will give approximately the same electrical results in point of efficiency. In deciding then upon the merits of a new design of switch, the commercial factor relating to repairs has therefore to be very largely considered, and had designers been able to guide their work more closely from the balance sheets of railroad companies, when such had been properly kept, instead of conforming to popular notions, very much more progress would have been made in this line during the last few years.

In closing this paper it might be well that I should remark that my experience has been largely confined to what is known as the commutated field method of control, and that I have naturally expressed many of the qualities of other methods in terms of this method. If these expressions are not judged satisfactory, I leave it for those who have had a similar experience with other systems to express in their criticisms the qualities of the commutated field system in their own terms.

LARGE CURRENT BATTERIES FOR EXPERIMENTAL WORK.

Those who want to work induction coils at odd intervals always find the battery troublesome, says *Industries*. They use bichromate cells, or various kinds of batteries with queer depolarizing liquids, and find them all equally objectionable. Every electrician knows all about Planté batteries, but one is inclined to wonder how often they are used for this kind of work. Nothing can be simpler than to use a few small current cells with a little secondary battery in parallel. There is then no trouble, and for intermittent and occasional work a large current can be obtained. It may seem rather late in the day to mention such a thing as this, but the obvious is frequently overlooked.

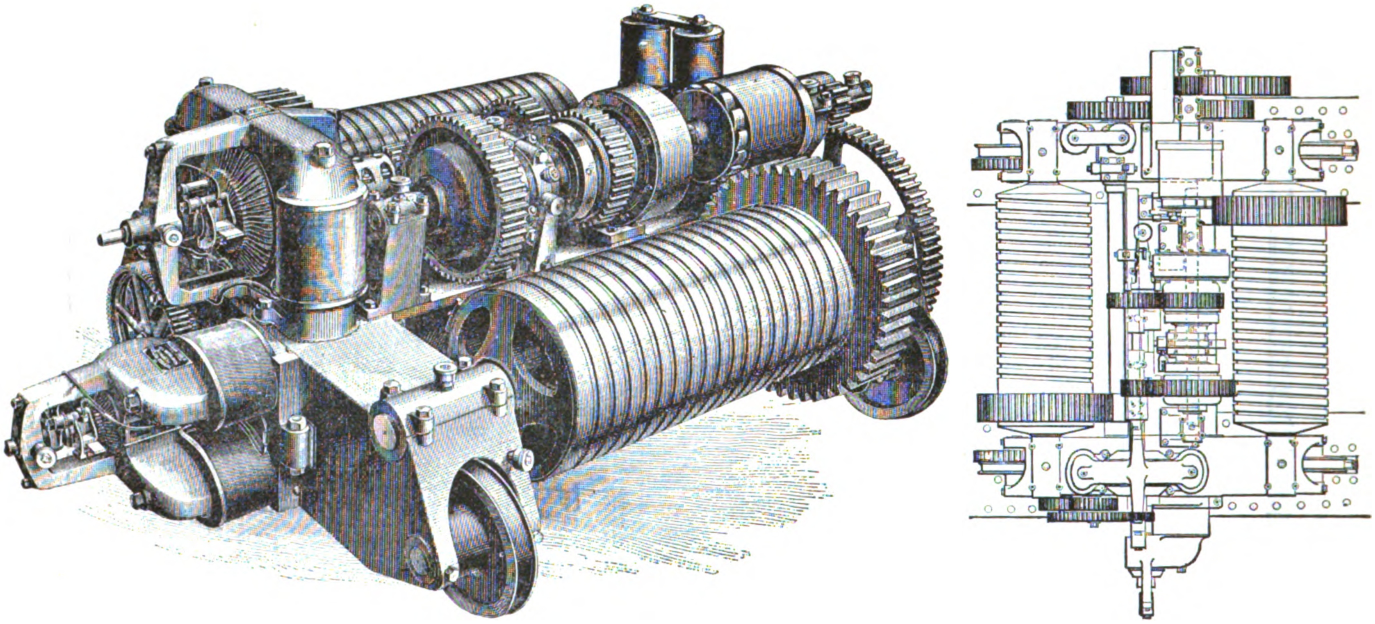
"DRUMMERS" AND THE TELEPHONE.

Traveling salesmen are not very favorably disposed toward the telephone. After quoting prices or selling goods to one concern they are likely to learn that other concerns in the same trade have been informed of the prices or sales, and that the information hampers them in their subsequent efforts to sell.

THE SHAW ELECTRIC TRAVELING CRANE.[1]

Probably the first triple motor crane put in practical operation was built from the designs of Mr. A. J. Shaw by the E. P. Allis Company and erected in their foundry in Milwaukee. Although this was an experimental machine and somewhat crude in many of its details it was pronounced superior to anything previously introduced. The molders were especially pleased with it, as it was far smoother and steadier in it movements and capable of much more accurate handling than the power cranes in use at that time.

From the accompanying engravings an idea of the general arrangement of the Shaw electric crane can be obtained. Fig. 1 is a perspective view of the trolley and Fig. 2 is a plan view of the trolley of a 15-ton crane. The bridge is moved along its tracks by means of a motor placed near one end, the power of which is transmitted through gearing to the driving wheels at each end. The trolley carries two motors, located at one side, one of which is arranged to move the trolley along the bridge while the other is so geared as to operate the hoisting drums. This crane, as are all built by this company, is fitted with duplex automatic brakes, to which in large part is due the accuracy with which the load can be handled in hoisting and lowering. These brakes not only insure against the accidental dropping of the load from any cause other than breakage of parts, but positively prevent any possibility of racing in lowering. They are entirely automatic in their operation, and do not depend for their action on the skill or vigilance of the operator. The mechanical brake is applied continuously by the reaction of the load itself, the force with which it is applied being proportional to, and increasing with the load, and released by the pull of the motor. The other is applied by a powerful spring, and is always "on" except when withdrawn by the action of a solenoid in series with the hoisting motor.



Figs. 1 and 2—The Shaw Electric Traveling Crane.

Without the mechanical brake the crane would race in lowering, as the magnetic brake is then withdrawn by the current actuating the motor, and both the motor and load act in the same direction. Without the magnetic brake the load could not be stopped promptly after either hoisting or lowering, on account of the momentum of the armature. Without the capability of instantly checking the movement of the load, accurate handling would be impossible, as when the current is thrown off it would always go a little too far or not far enough. The two brakes acting in combination give great accuracy of control, which, together with the extremely slow speed at which the crane may be run, enables the heaviest loads to be set with the greatest accuracy.

All the truck wheels are cast from charcoal iron, and the treads are chilled deep and hard and ground true. The shafts are large and the bearings unusually long. The machinery is so arranged that all parts are easy of access, and all important details can be removed and replaced without disturbing other parts. These cranes are built by the Shaw Electric Crane Company, of Muskegon, Mich., the sole agents for whom are Manning, Maxwell & Moore, of New York and Chicago.

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[1] *Iron Age.*

COMPARATIVE TEST OF HIGH AND LOW SPEED ENGINES IN ELECTRIC RAILWAY WORK.[1]

BY CHAS. W. WASON.

In making this second test[2], I have endeavored to eliminate some of the causes of error that were apparent in my first test. By means of a simple device gotten up and applied by our electrician, Mr. Robert M. Fuller, to hold the pointers of the ampere meters simultaneously with the sounding of the bell, the men were enabled to get the exact reading at each interval. By a simple arrangement of slips upon which the readings were taken, the electrical horse power of any reading of the ten hours is at once obtained.

In the test of the slow-speed plant, I endeavored to secure the mechanical horse power of the two Corliss engines, by means of indicator cards taken at the same instant every fifteen minutes. I am indebted to Mr. P. A. Patterson, our engineer, for a very accurate figuring out of them. From my slips I obtained the electrical horse power at the same instant, with the result as given below. I think but little reliability can be placed upon this owing to the sudden change of load.

In order to find the dead load, owing to friction in engines, countershaft and generators, I ran the engines, countershaft and two generators with the third and fourth as motors, with the result as here shown. I then got the friction load of each engine with the other engine, countershaft and generators. This is also here given.

The number of passengers carried on each of these days and the number of car miles made are practically the same, so that in this test the "misleading" element, thought by some to exist in the former, will not present itself.

There is a larger difference in coal consumed in favor of the slow speed than in the first test, but still it is not what I expected it would show. I have been an advocate of slow-speed engines for railroad work, but the results obtained from these tests cause me to doubt whether my position is tenable.

TEST OF HIGH AND LOW SPEED ENGINES.

MARCH 13 AND 20, 1892.

	High speed.	Low speed.
Average electrical horse power developed in 10 hours	601	630
Maximum " " "	859	966
Minimum " " "	345	363
Number gallons oil used in 10 hours	7 gallons.	7 gallons.
Water consumption for 10 hours	4,170 cu. ft.	3,660 cu. ft.
Water consumption per average electrical horse power per hour	40.2 lbs.	36.3 lbs.
Water evaporated per lb. coal per hour	6.5 lbs.	7.0 lbs.
Amount of bituminous slack coal used in 10 hours	38,000 lbs.	32,400 lbs.
Amount of ashes made in 10 hours	4,444 lbs.	5,197 lbs.
Amount of fuel per average electrical horse power per hour	6.3 lbs.	5.1 lbs.
Pounds of combustible per average electrical horse power per hour	5.5 lbs.	4.3 lbs.
Number pounds of coal per car mile	7.2 lbs.	6.4 lbs.
Average amperes per 10 hours	871	909
Maximum " "	1,240	1,360
Minimum " "	550	540
Average voltage per 10 hours	514	517
Maximum " "	585	530
Minimum " "	490	500
Number of readings of 15 seconds intervals	2,400	2,400
Average temperature of water from heaters	150°	195.5°
Average " " street main	39°	39°
Average " outside atmosphere	32°	36°
Condition of weather	Light snow	Cloudy.
Height of barometer	Not taken.	29.284 inches.
Average steam pressure as per automatic steam registering diagram	88 8 lbs.	99.3 lbs.
Maximum steam pressure as per automatic steam registering diagram	102 lbs.	104 lbs.
Minimum steam pressure as per automatic steam registering diagram	85 lbs.	91 lbs.
Average chimney draught	¼″	¼″
Number of motor cars run on our line	62	62
Number of tow cars run on our line	10	10
Number of miles made by our motor cars	4,125 92 mi.	4,132.11 miles.
Number of miles made by our tow cars.	821.30 miles.	679 66 miles.
Number of passengers carried on our cars	13,551	13,489
Number miles made by Brooklyn motor cars	85.25 miles.	74.30 miles.
Number of miles made by Brooklyn tow cars	42.21 miles.	35.42 miles.
Number of miles made by Broadway motor cars	117.10 miles.	117.10 miles.
Number of miles made by Broadway tow cars	None.	None.
Number of Brooklyn motor cars	4	4
Number of Brooklyn tow cars	2	2
Number of Broadway motor cars	5	5
Number of Broadway tow cars	None.	None.
Total number of motor car miles	4,328 27 mi	4,313.51 miles.
Total number of tow car miles	863.51 miles.	715.08 miles.
Total number of motor cars	71	71
Total number of tow cars	12	12
Total number of motor and tow cars	83	83
Total number of car miles made from power developed	5,191.15 mi.	5,028.59 miles.
Average horse power per car	7.24	7.59
Average of mean effective pressure, engine "Velda"	33.41 lbs.	
Average of mean effective pressure, engine "Jettie"	39.73 "	
Average of indicated mechanical horse power, engine "Velda"	358.9	
Average of indicated mechanical horse power engine "Jettie"	417.75	

Average indicated mechanical horse power, both engines	776.65	
Average of electrical horse power	647.33	
Excess of mechanical horse power over electrical	129.32	
Generator No. 14 as motor driving countershaft and other three generators light	47.653	E. H.P
Generator No. 13 as motor driving countershaft and other three generators light	52.3763	"
Generator No. 15 as motor driving countershaft and other three generators light	53.	"
Generator No. 16 as motor driving countershaft and other three generators light	47.32	"
Average of the above	50.06	"
Generators No. 13 and No. 14 as motors driving shaft, two generators light and engine "Jettie"	138.06	"
Generators No. 13 and No. 14 as motors driving shaft, two generators light and engine "Velda"	178.3529	"
Indicated mechanical horse power of engine "Velda" with jack-shaft	46.98	
Indicated mechanical horse power of engine "Jettie" with jack shaft	35.06	
Indicated mechanical horse power of engine "Velda" with countershaft and four No. 60 Edison generators light	76.57	
Indicated mechanical horse power of engine "Jettie" with countershaft and four No. 60 Edison generators	88.8	
Indicated mechanical horse power of engine "Velda" with countershaft and four No. 60 Edison generator and engine "Jettie"	166.77	
Indicated mechanical horse power of engine "Jettie" with countershaft and four No. 60 Edison and engine "Velda"	187.55	

I think I shall make one more test and then average them, which surely should give a fair comparison of the high and low speed plants.

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[1] Read before the Cleveland Electric Club.

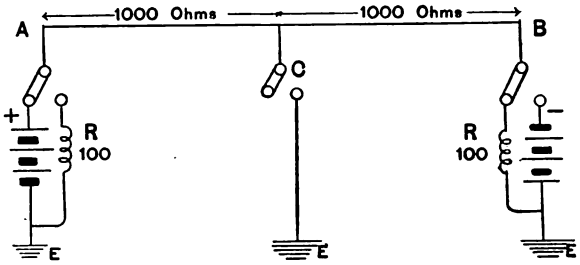
[2] For the first test see THE ELECTRICAL ENGINEER, Mar. 9, 1892.

Letters to the Editor.

WORKING EFFICIENCY OF TELEGRAPH LINES.

In connection with the communication of Mr. F. W. Jones in your issue of April 6, I would like to submit the conclusions arrived at in the following:

A B is a line of 2,000 ohms resistance; batteries at A and B respectively 100 cells, with internal resistances of 100 ohms each.



Elec. Engineer

The line at B being grounded through a compensating resistance of 100 ohms, gives a total resistance of 2,200 ohms to be overcome by battery at A giving (estimating the E. M. F. at 100 volts) $\frac{100}{2200}$ = .045 ampere current strength. Reversing the conditions, and throwing line to ground at A, through 100 ohms resistance, and putting battery at B to line we obtain the same result, ($\frac{100}{2200}$ = .045 ampere current strength). Is it not evident that neither battery can possibly furnish more than 0.45 ampere through the given resistance?

Now putting both batteries to line we obtain a current strength of .045 + .045 = .090 ampere. Now throw the line to ground at C. Does not battery A give a current through the 1,100 ohms resistance A to C of $\frac{100}{1100}$ or .090 ampere *all furnished by the battery at* A? And is not the same true of battery at B? And if each battery, in furnishing 0.90 ampere consumes a certain quantity per day of zinc, will not a decrease in current strength to .045 ampere be accompanied by a decrease in quantity of zinc consumed per cell? And if each battery furnishes but .045 ampere to the line of 2,200 ohms between A and B, and .090 ampere to line of 1100 ohms between A and C and B and C, does it not follow that each battery will consume more zinc in furnishing the latter current than the former? And if the consumption of zinc is the same in each case, is it not due to the increased chemical action set up in each battery by the current from the other? In view of the foregoing is it quite correct to say that the battery at A or B furnishes the same quantity of current to line of 2,200 ohms that it does to that of 1,100 ohms?

ST. LOUIS, MO., April 12, 1892. G.

[The article by Mr. F. W. Jones in our issue of April 20 furnishes the data necessary for the answers to the above questions. —EDS. E. E.]

THE CONSUMPTION OF ZINC IN BATTERIES.

In The Electrical Engineer of April 20, Mr. F. W. Jones, commenting upon my remarks in a recent number of the same (p. 365), in reference to the quantity of zinc consumed in a battery under different conditions, expresses the opinion that I have merely reaffirmed a certain fact "without carrying with it that elucidation so necessary to lower the conclusions of mathematicians to the plane of every-day workers in the telegraphic field." Whereupon he undertakes, as he tells us, to make the subject "a little clearer."

If Mr. Jones had turned back to page 74, section 154, of *Modern Practice of the Electric Telegraph* (edition of 1892), under the head of "Quantity and Cost of Materials Consumed in the Battery" I venture to affirm that he might have found the whole subject sufficiently "elucidated," not only without mathematics, but with the aid of copious quantitative numerical examples worked out in full. It seems to me scarcely worth while to occupy space in a technical journal with a detailed explanation of such an elementary problem, involving nothing more abstruse than a knowledge of Ohm's law, and of the electro-chemical equivalent of zinc. The illustrative example subjoined by way of elucidation is, however, open to criticism. Mr. Jones says:

> In a circuit of 1,000 ohms, 100 cells will give 100 *times* stronger current than is given by one cell *alone* in the circuit, expending 10,000 more energy, and consuming 10,000 times more zinc. Each cell working in the series of 100 will consume 100 *times* more zinc than if it were unassisted by the other 99 cells.

It is scarcely necessary to point out that the above proposition could be true only if the internal resistance of the battery were zero, a condition unattainable in practice. If we assume the internal resistance of a gravity cell of the usual size to be 3 ohms, a fair approximation, we should have in the first instance:

E. M. F. $= 100$ volts; $r = 300$ ohms; $R = 1000$ ohms.

Current, by Ohm's law, $100 \div (300 + 1000) = .0769$ ampere.

And in the second instance:

E. M. F. $= 1$ volt; $r = 3$ ohms; $R = 1000$ ohms.

Current by Ohm's law, $1 \div (3 + 1000) = .000998$ ampere.

The current in the first case would be only about 77 times that in the second case, instead of 100 times as great, as Mr. Jones computes it. It might also have tended to further elucidation of the subject if Mr. Jones had explained *why* it is that the expenditure of energy and the consumption of zinc are in proportion to the square of the current, instead of contenting himself as he has done, with a mere reaffirmation of that fact.

Franklin L. Pope.

New York City, April 21, 1892.

Legal Notes.

THE INCORPORATION OF THE GENERAL ELECTRIC CO.

Governor Flower has filed the following memorandum with his approval of Senate bill No. 634, entitled "An act to incorporate the General Electric Company":

> The approval of this bill must not be considered as establishing a precedent for future legislation of this character. The measure is approved because it is claimed that its objects will keep within the State a corporation which professes to be ready to invest a large amount of capital, and which, without the concessions allowed by its proposed charter, would be incorporated under the laws of New Jersey. The reduction of tax for incorporation from one-eighth of one per cent. upon capital stock to one-twentieth of one per cent. is to make the tax uniform with that required by the law of New Jersey, so far as this corporation is affected.
>
> The other concessions in the bill are mainly such as have already been incorporated in the amendments to the stock corporation laws, which are now pending in the Legislature, and which seem likely to be passed before the close of the session. These indicate a growing sentiment in favor of less severe restrictions in our corporation laws, to the end that the investment of capital may be encouraged within the State. This is in line with the recommendations of my annual message, and reveals a tendency which, in my judgment, is wise, and will result beneficially to industrial and commercial interests.

Society and Club Notes.

FRANKLIN INSTITUTE—ELECTRICAL SECTION.

At the last meeting of this section on March 1—

Mr. C. W. Pike read a paper on "The Constant Shunt Method for the Measurement of Continuous Currents," with blackboard illustration. Referred for publication. In discussion thereon, Mr. Carl Hering stated that this method had been used successfully at the Munich Exhibition of 1882, and by himself at the Institute's Electrical Exhibition of 1884. In the latter case copper wire was used throughout, making the rate of temperature variation more regular. Mr. Willyoung also stated that he had used this method satisfactorily.

Prof. E. J. Houston read a paper on "Cerebral Radiation" which was discussed at some length and referred for publication.

Mr. Carl Hering gave some data submitted by the Oerlikon Works for the power-transmission plant at Niagara. The current furnished would be equally suitable for motors, arc and incandescent lights. The dynamo is a three-phase, separately excited machine of 5,000 h. p., and 96 per cent. efficiency. Its drum armature is made up of copper bars, is 10 feet in diameter, and, running at 250 revolutions per minute, will furnish a current in each of the three coils of 3,000 amperes, at 600 to 700 volts. The current from each machine feeds through two 2,500 h. p. transformers, capable of reducing from 25,000 volts. Cost of the line to be $20,000 for 32,000 metres, to carry up to 10,000 h. p. Total estimated cost, including generators, exciters, transformers and lines, to be $180,000.

ANNUAL ELECTION AT THE NEW YORK ELECTRIC CLUB.

The annual meeting of the New York Electric Club was held at the club house on April 21, when the following ticket was unanimously elected. The names in italic are those of officers receiving the honor of re-election: President, *Samuel Insull*; vice-presidents, *Edward Weston*, E. A. Leslie, *W. L. Candee*, H. J. Smith; secretary, *Stephen L. Coles*; treasurer, *Geo. M. Phelps*; board of managers, *Chas. D. Shain*, *Joseph Barre*, James Kempster, *H. D. Cheever*, *T. C. Martin*, John A. Seely, R. B. Corey, W. J. Morrison, *E. F. Peck*, *Dr. J. B. DeLery*, *E. E. Bartlett*, Frank R. Chinnock; committee on membership, *Charles Dutton*, C. E. Stump, *Geo. T. Manson*, *Jos. Wetzler*, C. O. Baker, Jr.

The subscriptions made by members towards lifting the Club's debt, in response to the appeal of the Board of Managers, have been so large that there is now not only the intention to carry on the work of the club as heretofore, but the hope to continue in occupancy of the commodious house at 17 East Twenty-second street.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the monthly meeting of the Council of the Institute held April 19, the following gentlemen were admitted to associate membership:

Badt, Francis B., manager of mining department, Thomson-Houston Electric Co., 6506 Lafayette avenue, Englewood, Ill.
Blades, Harry H., general superintendent the Detroit Motor Co., 1343-1355 Cass avenue, Detroit, Mich.
Coolidge, Charles A., superintendent and electrician Northern Improvement Co., Centralia, Wis.
Cory, Clarence L., professor of electrical engineering, Highland Park College, Des Moines, Ia.
Edwards, James P., firm of W. A. & J. P. Edwards, electrical contractors and engineers, Graniteville, S. C.
Flather, John J., professor of mechanical engineering, Purdue University, Lafayette, Ind.
Higgins, Eugene, assistant electrical engineer, with Frank B. Rae, 802 Hammond Building, Detroit, Mich.
Hill, George, chief engineer and general manager, Carrere & Hastings, 44 Broadway, New York City.
Hoopes, Arthur, experimenter, Edison Laboratory, Orange, N. J.
Marvin, Harry N., secretary and expert, Marvin Electric Drill Co., Schenectady, N. Y.
Metcalf, George, R., electrical engineer, with C. O. Mailloux, 45 William and 404 West 22d streets, New York City.
Parker, Hershel C., assistant in physics, Columbia College, 21 Fort Greene Place, Brooklyn, N. Y.
Scott, Charles F., assistant electrician, Westinghouse Electric Manufacturing Co., Pittsburgh, Pa.
Smith, T. Jarrard, manager electrical department of The E. S. Greeley & Co., 5 and 7 Dey street, New York City.
Sperry, Elmer A., electrical engineer, Sperry Electric Mining Machine Co., Chicago, Ill.
Stilwell, Lewis B., electrical engineer, Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.
Tischendoerfer, Fred. W., electrical engineer, Eickemeyer & Osterheld Manufacturing Co., Yonkers, N. Y.
Waterhouse, Lawrence Maxwell, consulting and practical electrical engineer, 16 St. Michael's Place, Brighton, Eng.
Wurts, Alexander Jay, electrical expert, Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.

The following were transferred to full membership:

Ayer, James I., general manager Municipal Electric Light and Power Co., 322 Pine street, St. Louis, Mo.
Emery, Charles Edward, consulting engineer, Bennett Building, New York City.

NEW YORK ELECTRICAL SOCIETY.

The 144th meeting of the New York Electrical Society took place on Thursday, April 21, at 8 p. m., at the Metropolitan Telegraph and Telephone Company's Central Exchange, 16 and 18 Cortlandt street. Thanks to the courtesy of the company, the members of the society were afforded the fullest opportunity to inspect and study this magnificent exchange, said to be the finest and costliest in the world. Only by such an inspection as this could an intelligent appreciation be had of the complexity of modern telephonic work, and of the extent to which the utmost resources of engineering and ingenuity are drawn upon to furnish telephonic intercourse for some ten thousand subscribers with lines almost wholly connected by subways. An opportunity was also given to witness the operation of the long-distance service. Mr. J. J. Carty, the electrician of the company, gave a popular running commentary upon and description of the various apparatus by means of which the exchange does its work.

Reports of Companies.

THE GENERAL ELECTRIC CO.

WITH the object of taking care of the floating debt of the Edison General and Thomson-Houston companies, forming the General Electric Co., it is proposed to issue $4,000,000 of 6 per cent. bonds.

The Edison General Electric Co. has declared a quarterly dividend of 2 per cent. The Thomson-Houston Electric Co. has declared a quarterly dividend of 1 per cent. on its common stock.

Personal.

MR. FREDERICK A. LA ROCHE.

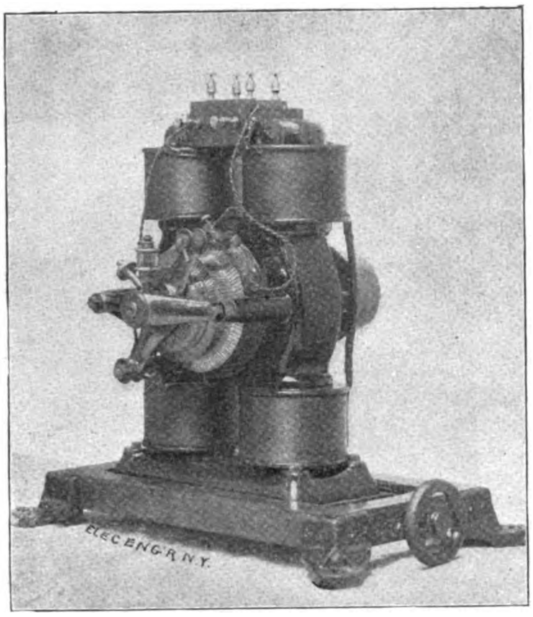
STANDING, as he does, at the head of a company enjoying so good a commercial and electrical reputation, the career of Mr. Frederick A. La Roche cannot fail to be of interest to his fellow-workers in the field as well as to all who have struggled against odds for recognition and success.

FREDERICK A. LA ROCHE.

Interested almost from infancy in things scientific, at the age of fourteen he took up the study of chemistry in this city, and, three years later, having in the mean time removed to Philadelphia, he completed a course of civil and electrical engineering under Prof. Beck, of that city. Then followed the formative period of Mr. La Roche's life; a period of more or less unsuccessful experimenting with electrical apparatus, where each new failure taught some lesson and each gleam of success incited to further effort.

In 1880 he began the manufacture of dynamo machinery and electrical apparatus, and was shortly afterward elected manager of the electric lighting company of Germantown, Pa. This plant was in so bad a condition that it had ceased to operate, and the task accomplished by Mr. La Roche was to turn it into a paying investment.

Tiring of work in which his inventive powers were hampered by routine duties, Mr. La Roche and several associates in 1887 entered into a copartnership for the manufacture of dynamos and motors. This, however, was soon dissolved and, on his own responsibility, Mr. La Roche founded the present well-known works that bear his name.



LA ROCHE CALIBRATING DYNAMO.

One of the latest examples of Mr. La Roche's skill as a designer is the "Special" calibrating dynamo shown in the accompanying illustration. This machine has a range of E. M. F. of from $\frac{1}{10}$ of one volt to 12,000 volts, and is used in the Queen & Co. laboratory for calibrating the delicate instruments manufactured by that firm.

Mr. La Roche has long been a contributor of new and useful ideas in the field of practical electricity, and his success is due to implicit belief in himself and untiring effort to make others to believe in him.

MR. NIKOLA TESLA.

THE many friends of Mr. Tesla will be grieved to learn that he has just sustained a severe bereavement in the death of his mother, with the intention of seeing whom he made his recent trip to Europe. Owing to this loss, Mr. Tesla has been detained in Gospic, Lika, and he will not return to this country as soon as he intended when he left here. It is believed that he will return early next month.

A WEDDING IN TELEGRAPHIC CIRCLES.

MISS ELIZABETH DEAN LOWERRE, daughter of Mr. Thomas H. Lowerre, Jr., was married last week at her father's home, 45 East Sixty-seventh street, to Mr. Charles Patterson Bruch, by the Rev. Dr. Ensign McChesney. Mr. Bruch was for many years the efficient secretary of the Telegraphers' Mutual Benefit Association. He then became connected with the old Empire City Electric Company, and also represented non-magnetic watch interests. For some time past he has been on the executive staff of the Postal Telegraph-Cable Company, with Mr. W. H. Baker.

Miss Edith Lowerre was the maid of honor. The bridesmaids were Miss Leila Wright, Miss Ida Schlemmer, and Miss Algie M. Hardwick, of Montgomery, Ala. Edward B. Bruch was the best man, and Charles D. Smith, Theodore H. Lowerre, Henry C. Gedney, W. D. Morgan, and Howard G. Kitt were the ushers.

A reception after the ceremony was attended by Dr. Norvin Green, John Van Horne, Commodore and Mrs. Henry Erben, Commodore and Mrs. McCann, Mr. and Mrs. Thomas A. Edison, Mr. and Mrs A. B. Chandler, Mr. and Mrs. T. L. Cuyler, Jr., Mr. and Mrs. D. H. Bates, Mr. and Mrs. William H. Baker, Mrs. Kate P. Bruch, Mr. and Mrs. Charles Lowerre, Mr. and Mrs. E. T. Gilliland, Mr. and Mrs. T. A. Brooks, Mr. and Mrs. G. F. Fagan, Mr. William Ford Upson, Mr. Edward F. Cummings.

MR. THOMAS WOOD has been selected by the directors of the new People's Electric Street Railway Company, Sandusky, O., as manager. The company expect to have their cars running by the first of next month.

THE MUNICIPAL PLANT OF THE CITY OF EASTON, PA.

About two years ago, the city of Easton found it necessary to enlarge their electric light plant. The old plant consisted of two 60 h. p. Ide automatic engines, built at Harrisburg, with an intermediate shaft containing four pulleys, two 70 h. p. return flue tubular boilers with Weitmeyer setting, one 150 h. p. Wainwright feed-water heater, and the necessary connections.

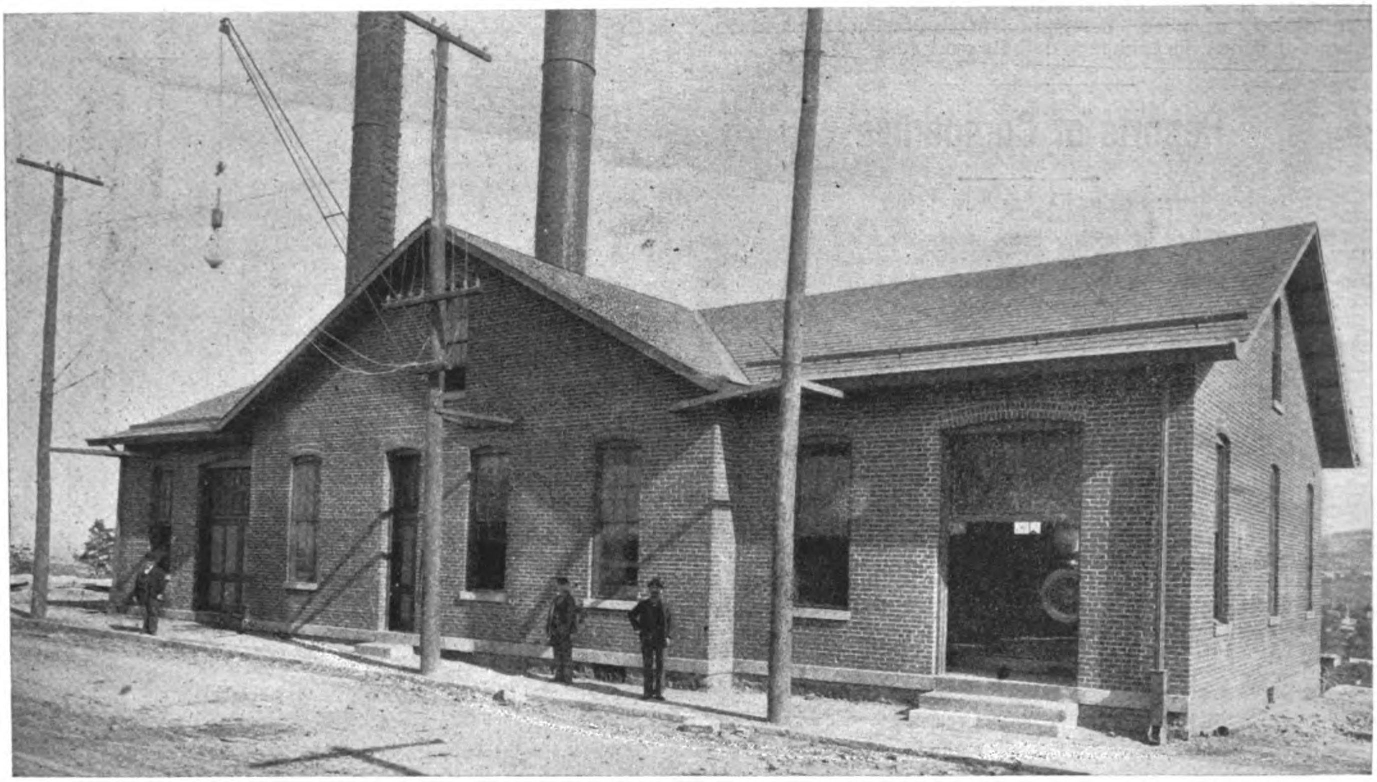


Fig. 1.—Municipal Plant of the City of Easton, Pa.

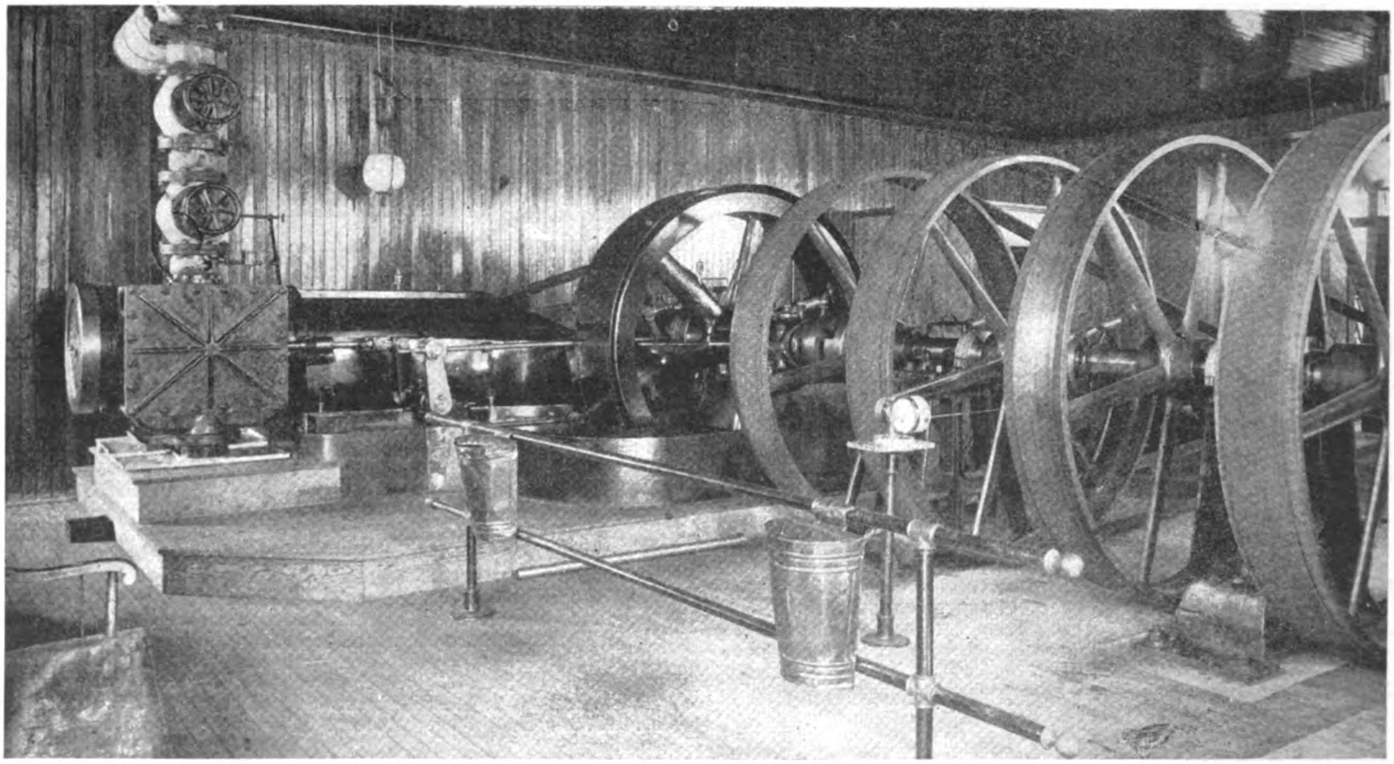


Fig. 2.—Municipal Plant of the City of Easton, Pa.

The John T. Noye Manufacturing Co., of Buffalo, N. Y., were awarded the contract for the enlarging of the old plant, and in doing so, took out all of the above steam plant, and in its place supplied two engines of 200 h. p. each, of what are known as the heavy duty "B" style type. The cylinders are 18 inch bore and 24-inch stroke, the engines running at 170 revolutions. The governor was placed in the fly-wheel. An intermediate shaft was placed between the two engines, connecting on to each engine by suitable clutch couplings, with four 84-inch drive pulleys on the shaft. The shaft, as shown in Fig. 2, is supported upon handsome cast-iron pedestals. There were supplied also three boilers, 74 inches diameter and 16 feet 6 inches long, with 126 three-inch tubes in each boiler; also one 400 h. p. Wainwright horizontal heater, and complete settings of the Weitmeyer improved gas and smoke consuming furnaces.

Each smokestack, as seen in Fig. 1, has a suitable ladder going to the top; the stacks themselves being 45 inches diameter, 70 feet high; provisions being made in this arrangement for another boiler at a later period. The entire plant is fitted out with all the little conveniences in connection with a modern plant. Mr. Robert H. Lerch, the superintendent of the plant, speaks very highly of the operation of the Rice engines.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED APRIL 12, 1892.

Alarms and Signals:—

Alarm for Hot Axles, A. Backhaus, 472,688. Filed Sept. 4, 1891.

Conductors, Conduits and Insulators:—

Insulator-Support, D. Doren, 472,529. Filed July 20, 1891.

A glass insulator supported upon an iron pin having a wooden thimble screwed upon it and into the cavity in the insulator.

Electric Conductor, W. R. Patterson, 472,648. Filed Aug. 31, 1891.

A conductor insulated with a composite covering of fibrous material and waterproof insulation, the latter forming the entire outer covering and alternating with the former in longitudinal annular sections next the conductor.

Joint for Electric Conductors, T. F. O'Connor, 472,983. Filed Jan. 2, 1892

A joint wherein the adjacent ends of corresponding conductors may be simply, cheaply and effectively united.

Insulator Bracket, C. Wirt. Design 21.454. Filed Oct. 23, 1891.

Insulator Bracket, C. Wirt. Design 21,455. Filed Oct. 23, 1891.

Distribution:—

Electric Lighting System, J. M. Lockwood, 472,623. Filed June 22, 1891.

Consists of a solenoid in the main circuit, a bar moving therein, a train of gearing automatically wound by the movement of the bar, a rotating disc and brush adapted to be connected in circuit with an alarm at the source of generation and a plate at the upper end of the bar to arrest the movement of the gearing.

Dynamos and Motors:—

Dynamo-Electric Machine, L. S. M. Pike and H. T. Barnett, 472,628. Filed Feb. 5, 1892.

Employs an annular stationary electromagnet, two concentric circles of laminated polar projections arranged in radial pairs, and sector-shaped laminated inductors revolving in proximity to the polar projections.

Electric Motor or Generator, R. M. Hunter, 472,706. Filed Nov. 12, 1891.

Has for its object to permit the brushes to be maintained at fixed points by changing the direction of rotation of the armature or varying speed.

Dynamo-Electric Machine, G. E. Dorman, 472,943. Filed Dec. 17, 1890.

Claim 1 follows:

A series of inwardly projecting pole-pieces in combination with a series of coils about such pole-pieces, each of said coils being curved to conform with the surface of a cylinder.

Lamps and Appurtenances:—

Flexible Supporting-Arm for Electric Lamps, L. T. Stanley, 472,611. Filed Oct. 17, 1891.

Electric Search Light, B. B. Ward, 472,721. Filed Jan. 13, 1890.

Consists of a cylinder provided with doors at each end and projections with movable caps, in combination with a reflector, lamp, frame, base, shaft, cord, and pulley with suitable electrical connections.

Electric Arc Lamp, R. E. Ball, 472,747. Filed Oct. 10, 1891.

An arc lamp, one of whose carbons is in the shape of a flat bar the end of which is adapted to move back and forth with relation to the other carbon which is fixed.

Incandescent Electric Lamp, G. C. Baillard, 472,800. Filed Sept. 22, 1891.

A socketless incandescent lamp in which the connections between the terminals and the circuit wires are made directly upon the base.

Incandescent Electric Lamp, G. C. Baillard, 472,801. Filed Sept. 22, 1891.

Similar to No. 472,800.

Arc Light Hanger, C. A. Pfluger, 472,935. Filed May 11, 1891.

Miscellaneous:—

Electromagnetic Valve-Controller, O. E. Lundstedt, 472,579. Filed Aug. 6, 1890.

Bracket for Electric Heaters, G. D. Burton, 472,634. Filed June 26, 1891.

Phonograph, J. L. Skilhin, 472,631. Filed Sept 12, 1890.

Art of Making Tin Plates, G. H. Benjamin, 472,691. Filed Nov. 11, 1890.

Operation consists in immersing the plate blanks in an electrolytic liquid consisting of a solution of a neutral salt and afterward in another electrolytic liquid having an acid reaction.

Electric Elevator, C. R. Pratt, 472,909. Filed April 8, 1891.

Has for its main object to provide against accidents and also to supply an apparatus easily controlled by the elevator attendant.

Magic-Lantern Advertising Apparatus, W. G. Spiegel, 472,912. Filed Sept. 15, 1891.

Cable Rack, W. M. Goodridge, 472,947. Filed Nov. 30, 1888.

Electrical Surgical Instrument, S. R. Bradley, 472,968. Filed Feb. 4, 1892.

An arrangement for detecting the presence of foreign matter in the human system.

Railways and Appliances:—

Trolley-Wire Clamp, M. M. Wood, 472,596. Filed May 14, 1891.

A clamp having two independent portions pivotally supported upon one another and provided at one extremity with clamping jaws and upon the other with means for securing the clamp to its support.

Safety Attachment for Overhead Electric Wires, C. D. Brown, 472,784. Filed Jan. 8, 1891.

An overlying loop extending from the trolley wire and surrounding the guard wire which is electrically connected with the ground.

Electric Railway Wire Suspension, A. Philipsborn & W. Reichel, 472,810. Filed Nov. 27, 1891.

Employs a second wire attached to the working wire and running nearly parallel with it; a rigid spreader between the wires and a cross-wire connected to the spreader.

Trolley-Wire Support, F. C. Prickett, 472,953. Filed Dec. 14, 1891.

Comprises a vertical bar having at one end a cavity and a groove communicating therewith at its lower margin and opening on opposite sides of the bar; a retaining plate being connected to the side of the bar and overlying the cavity and groove.

Switches and Cut-Outs:—

Electric Switch, L. T. Stanley, 472,610. Filed Sept. 24. 1891.

A push-button switch employing a flat, resilient strip as the actuating spring.

Telephones and Apparatus:—

Circuit for Multiple-Switchboard Systems of Telephone Exchanges, J. A Seely & C. E. Scribner, 472,772. Filed Nov. 15, 1886.

Provides means for connecting metallic and ground circuits for different subscribers with the same boards, and also uniform tests for determining at one board whether any line is in use at another.

Adjustable Microphone, H. O. Henneberg, 472,806. Filed Oct. 10, 1891.

Consists of a sounding funnel and vibrating membrane secured together and rotatably mounted in a frame; a carbon plate secured to the membrane and carbon bodies supported upon a flexible disc and pressing against the plate.

Canopy Telephone-Exchange Switchboard, C. E. Scribner, 472,956.

Claim 1 follows:

The combination of a switchboard containing the switches of a portion of the telephone lines of the exchange, of a canopy board placed above said switchboard, said canopy board containing the switches of other lines of the exchange.

THE BRITISH GUIANA ELECTRIC LIGHTING AND POWER CO., LTD.

A VERY fine Thomson-Houston central station has just been completed at Georgetown, Demerara, by Mr. A. H. Hardy Trott, electrical engineer for the contractors. The station is a sheet iron building erected specially for the purpose. The plant consists of two Thomson-Houston alternators of 650 lights each, and two arc machines of 12 and 30 lights respectively. These are driven by a 125 h. p. McIntosh & Seymour engine single, and a compound McIntosh & Seymour engine of 165 h. p. which is now to be run condensing. Steam is furnished by 200 h. p. of Babcock & Wilcox boilers and 150 h. p. of Grant multitubular. The demand for the light is large and growing, and a 1,300-light alternator is to be added. Mr. H. T. Moore will take charge of the plant as superintendent, relieving Mr. Trott, who will return to this country next month.

NEW SMALL EDISON LAMPS.

THE Actors' Fund Fair to be opened on May 2, at Madison Square Garden, New York, will afford electricians the first opportunity of beholding and appreciating the progress that has been made in the manufacture of incandescent lamps of small candle power. The entire illumination of the fair and the booths has been confided to the Edison General Electric Company in so far as the lamps and special design and apparatus are concerned, and every lighting effect produced will be absolutely novel. Each stand will be especially illuminated by means of the beautiful small lamps and among the wonders of the Fair the electric decorative illumination will be, perhaps, the greatest and most worthy of attention.

NEW YORK NOTES.

"A THING OF BEAUTY."—Speaking of handsome lamps it is but right to say that the beautiful "Ornamental" arc lamp which Manager Corey of the Electric Construction & Supply Co. has had placed on exhibition in his private office is certainly without a peer. This lamp is a marvel of finished workmanship, irrespective of the well-known mechanical features of the Ward arc lamp. It is wrought in highly polished brass and is of exquisite design To appreciate fully its peculiarly desirable points for hotel lobbies, handsomely equipped dining-rooms, etc., it must be seen. This company are also placing on the market a very effective short ornamental lamp expressly adapted for buildings with low ceilings.

THE PREMIER ELECTRIC CO., formerly of 11 Whipple street, Brooklyn, have moved into their new factory which has just been completed. With increased facilities as regards room, machinery, etc., they are now in a position to fill all orders for their Premier fan outfits with promptness. Their business has been so large since the introduction of their very small and reasonable priced motors that they have been compelled to build a factory and can now be found at 17 and 19 Whipple street.

PRACTICAL INSTRUCTION TO THE STUDENT.—The Premier Electric Co., 17 and 19 Whipple street, Brooklyn, are furnishing a complete set of castings and all material necessary for the putting together of their small motors. These little motors are about five inches high and will run on one cell of battery at about 3,000 revolutions, developing about $\frac{1}{80}$ h. p. or sufficient to run a ventilating fan, small or model machinery, etc. This is a rare chance for the student in electricity, furnishing as it does practical instruction in construction and winding. They issue a special circular and price list.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Successful business houses are generally known by their distinctive style of advertising.

THE ERIE CITY IRON WORKS' ELECTRIC LIGHT PLANT.

THE DUPLEX ELECTRIC Co. of Corry, Pa., last October, installed in the Erie City Iron Works a plant consisting of two 40-light Duplex arc dynamos of the type shown in Fig. 1 of the accompanying illustrations, with 60 Duplex arc lamps, and reset an old 325-light United States dynamo already in use, besides rewiring the works. These machines are driven by two Erie City automatic engines of 75 h. p. each, and the whole constitutes the largest isolated plant in Northwestern Pennsylvannia. The plant is shown in Fig. 2. One notable feature is the entire absence of rheostats or resistance coils of any description in connection with the arc generators. The rheostat seen on the wall near the switchboard is used in connection with the incandescent machine.

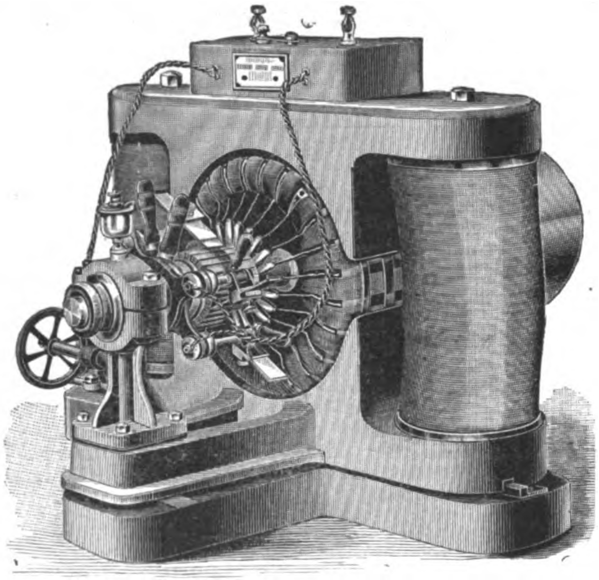


FIG. 1.—THE "DUPLEX" ARC DYNAMO.

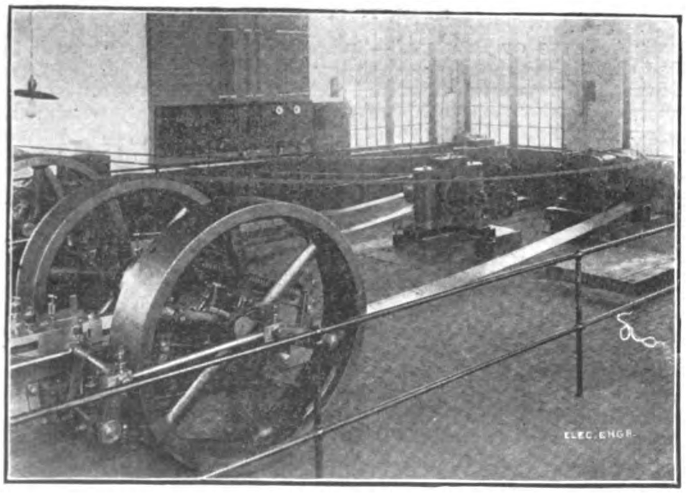
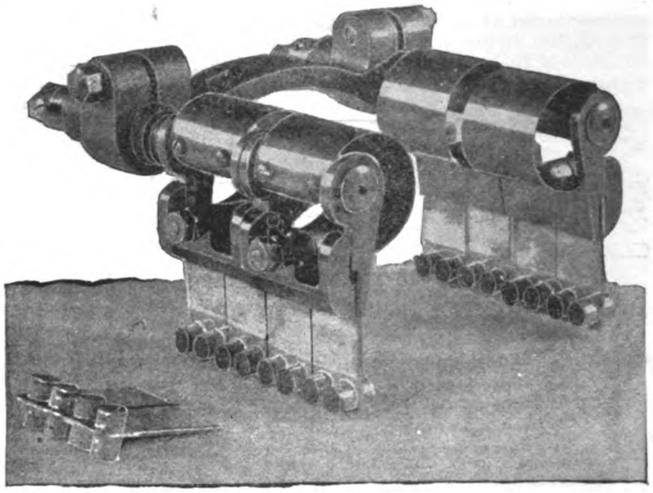


FIG. 2.—"DUPLEX" PLANT, ERIE CITY IRON WORKS.

A Duplex focusing lamp for making blue prints has recently been ordered as an addition to this plant, and that the whole is all that can be desired is attested by a letter from the Erie City Iron Works saying: "Our plant is running perfectly satisfactorily in every way, and we are much pleased with it."

THE EICKEMEYER-FIELD CARBON BRUSH.

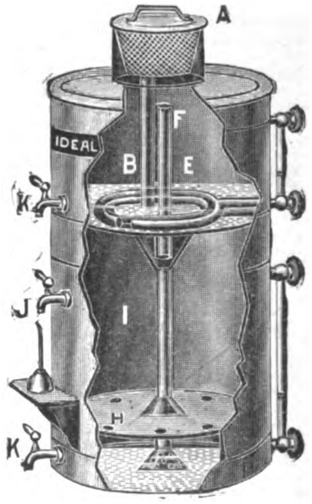
THE accompanying illustration shows a reversible carbon brush and holder in use on the Eickemeyer-Field dynamos and motors. Each set comprises four brushes like the one shown detached, which consists of four carbon pencils attached to the extremities of a divided blade spring, each carbon having an independent motion with a minimum pressure on the commutator. With this arrangement, the wear on the brushes is said to be inappreciable, while that upon the carbons themselves is but slight. When one side of a brush is finally worn down, it can be reversed and the same amount of service obtained from the other side. In addition to these advantages the brushes are interchangeable and require no adjustment.



EICKEMEYER-FIELD CARBON BRUSH.

THE "IDEAL" STEAM OIL REFINER.

THE accompanying illustration shows an oil refiner recently introduced by the Purity Oil Filter Mfg. Co., of Pittsburgh, Pa., and aptly named by them the "Ideal."



"IDEAL" STEAM OIL REFINER.

As will be seen, the construction of the filter is exceedingly simple. It is entirely automatic, can be cleaned without drawing off the oil from the reservoir, and is operated by steam and water, no filtering material of any kind being used. The operation is as follows: The chambers E and I being filled with water to a depth of 6 inches and steam connection being made with the coil, the dirty oil is poured into the receiver A, where it is strained into the pipe B and carried to the bottom of the water in chamber E. A little steam is then turned on and the refining process commences. As more dirty oil is added at the end of the first 24 hours, some of that first put in overflows into the pipe F, and is carried to the bottom of the water in the reservoir I and thence up and around the disc H. As each day's accumulation of dirty oil is added at A, the refined oil is raised until it reaches the level of the cock J, where it may be drawn off ready for a second using. The cocks K K are for the purpose of drawing off the dirt and water. The heat of the steam coil thins the foul oil and separates the grease and other deleterious matter, which settles at the bottom of the chamber E.

The Citizens' Traction Railway, the Chautauqua Lake Ice and Cold Storage Co. and the Allegheny County Court House and Jail, all of Pittsburgh, have adopted the Ideal refiner and are uniformly pleased with their choice.

THE NEW CATALOGUE OF THE ELECTRICAL SUPPLY COMPANY.

WE have before us a work which we are at a loss to classify. In many respects it is an extraordinary book. The quiet and quaint design of the gold-embossed cover gives but a foreshadowing of the feast which is spread within.

Catalogues of electrical goods have been issued for the past decade. We have seen many, if not all, of them; each was characteristic in its contents and make-up; most of them are a credit to their authors, and so far as we have known effectual in the results aimed at. As we looked over their closely printed pages, crowded with illustrations, we had no fault to find and we could not but think that they perfectly filled their mission.

The book before us is a revelation; it marks an epoch in electrical catalogue making, but we have our doubts about the fitness of it to the present day. It is ahead of its time. In its style of binding, in the evident lavish expenditure of care, intelligence, and money to make each of its 500 pages perfect it surpasses anything we have as yet seen. We even wonder if from its inception it has not grown, and developed, and expanded far beyond the idea of its compiler. We have known Mr. F. S. Terry as a worker, embodying the foremost principles and ideas of the cause which he has so diligently espoused, and we can imagine that there has been an enthusiasm, a tireless energy behind this which has made it a part of his very existence for the past few months, but still we question if it has not overlapped the course it was to have run.

Time was when a scanty outline or murky silhouette of the object was sufficient to convey to most minds the idea of its form and construction. Is it not so now? Is there a call for this artistic delineation? We turn these pages and while we question the elaboration we can but admire the genius of the artist, who has so cleverly caught the light and with his pencil molded it into almost moving, working pictures of the inanimate objects so familiar to the every-day life of the practical electrician and contractor.

Probably we are at fault in criticising the aim or intention of Mr. Terry in issuing this magnum opus of electrical catalogues. We are reminded of the instructions to a novice in the art of sculpture. He was told, "Just take your block of marble and cut away what you don't want, which of course will leave what you do want." Simple enough. But the confident beginner soon discovered that while he knew what he wanted, it was an insuperable task to tell what he didn't want. But in the collation of this book there is seen the stroke of the master hand which has cut and chipped and chiseled without falter, so that there remains only a concise, descriptive and illustrated epitome of the extensive line of goods manufactured by the company responsible for its publication.

The arrangement is embraced under the several headings: introductory; insulated wires, cables and cords; equipment material and special line devices; station equipment material; house equipment material; electric motor; tools; construction material; general station supplies; manufacturer's special material; electrical testing instruments; miscellaneous tables, formulæ, etc.

The superscription of the book reads, "Electric Light and Power Supplies, the Electrical Supply Company, Chicago, Ill. Catalogue No. 23." As a catalogue, if we must say catalogue, it will by reason of the variety and newness of its contents, its completeness up to date, its many tables, formulae and diagrams, delight every central or isolated station, electrician, engineer or buyer of electrical goods, whose good fortune it is to obtain a copy.

MR. E. E. RIES.

MR. ELIAS E. RIES, the well-known inventor, is, we understand, hard at work upon a novel and remarkable electric railway system which after many years of experimenting he has succeeded in perfecting. In this new system neither overhead wires, storage batteries, surface conduits nor underground conduits are employed; the motive current being conveyed to the car by induction from buried conductors extending along the line of travel. Mr. Ries who has given considerable attention to the development of electric railways is of the opinion that the system will revolutionize existing methods of operating railways electrically, it being not only entirely free from the objections which the overhead trolley and other existing systems are open to but also efficient and simple in operation. Mr. Ries while very reticent upon the details, has made practical demonstrations of his system with entire success, and expects to be able to make the details of the same public shortly.

There can be no doubt that if these claims can be substantiated, a most important advance in the art of electric locomotion will have been made that cannot but lead to a very general extension of this modern application of electric power as well as give rise to an entirely new type of electric railway construction.

ELECTRIC RAILWAY DEVELOPMENT AT TROY, N. Y.

THE TROY AND LANSINGBURG RAILROAD have begun the Broadway extension and loop to the Union Station. Poles have been set, and as soon as possible wires will be strung. It is expected that but a short time will elapse before regular trips will be made. The Fourth street extension to the Iron Works will be pushed as soon as the depot loop is in working order. The barn owned by the Troy and Lansingburg Railroad Co. has been transferred to the Troy City Railway Co., who will at once proceed to fit it up as a power station, plans for which are in course of preparation by M. F. Cummings & Son. The boilers are being made by T. S. Sutherland. The new station will have a frontage of 100 feet, with a depth at present of 180 feet. It is thought it will be necessary to extend still further to the westward.

The Brady property will not be used at present, but President O'Neil states that eventually it may be desirable to use it as an extra power station. The present car barn at Albia (the eastern terminus of the road) will be retained and still used for housing the cars, as the first cars in the morning are started from that end of the route.

Nearly all the iron poles to be placed from River street to the Stone Bridge have arrived, and the wooden poles for the balance of the route to Albia are already on the ground awaiting the setting. The track is being relaid and reballasted for a long distance owing to the spreading and settling during the winter, and report states that the electric line will be in operation by June 1 next, which will require exceedingly rapid work.

WEBB'S CO-ORDINATE PAPER.

WE are in receipt of a sample of book of co-ordinate or cross-section paper devised by Prof. J. B. Webb, of Hoboken, N. J., which is admirably adapted for use in technical schools, laboratories, draughting-rooms and in general wherever it is desirable to represent graphically the results of tests or calculations.

The paper is heavy wove, of superior quality, with a smooth surface suitable for nice draughting and bearing erasures well and is affected but little by ordinary atmospheric changes. It is printed with a non-actinic, olive-colored ink and the paper has a bluish tint, so that good photographic negatives of drawings, showing the ruling, can be made; the combination, too, suits black, blue and carmine inks, so that handsome work can be done. The ink dries hard so as to bear the use of rubber. The printing is done with the greatest care from copies of an original plate, which was machine-engraved with every precaution to secure accuracy, and the printing plates are renewed from time to time, to maintain the absolute sharpness of the lines.

The fifth and tenth lines are made heavier and numbered in both directions from one corner of the paper, with a distinction in the type, so that any point on the paper can be definitely referred to by its co-ordinates. A table of natural tangents is also printed on the margin so that angles can be laid off with ease and accuracy equal to that of an eight-inch metal protractor.

Two sizes of paper furnished are: "large," 17¾ x 11⅜ inches, at seven, and "small," 11⅜ x 8¾, at four cents per sheet, with a liberal discount when ordered by the trade or quantity. The paper is punched and its edges colored, and covers punched to match are furnished at 25 and 35 cents each, so that paper and drawings can be preserved in a neat form. A sample book of twenty small sheets in a cover will be mailed to any address on receipt of one dollar. For paper or samples address J. B. Webb, Hoboken, N. J.

RACINE HARDWARE MFG. CO.

THE above concern, of Racine, Wis., builders of the Racine vertical automatic engines, are just in receipt of an order from P. L. Sword & Son, of Cleveland, O., for one 3 h. p., one 5 h. p., one 6 h. p., one 8 h. p. and one 10 h. p. engine, to be shipped immediately. Their engine trade is large and active.

ELECTRIC RAILWAY WORK IN CANADA.

AHEARN & SOPER, the electrical contracting engineers of Ottawa, Ont., agents for the Westinghouse Co., have secured the contract at Hamilton, Ont., for an equipment of 30 cars and three 250 h. p. generators. This fine equipment will be furnished as quickly as possible.

EDISON CENTRE OF DISTRIBUTION SAFETY CATCH HOLDERS.

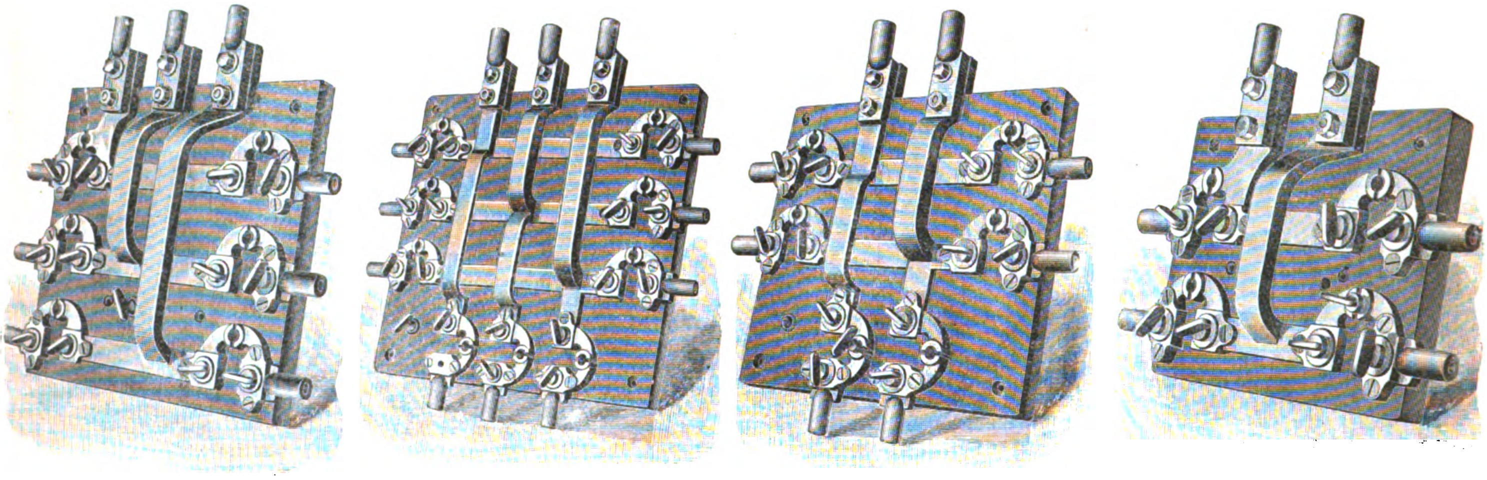
It is often necessary, in wiring a large building, to run a main line from the dynamo-room or street service wires to some point or points as centres of distribution whence smaller taps can be taken. In order to facilitate the control of the electric wires in buildings and further to safeguard them against accidents, the Edison General Electric Company have recently perfected their centre of distribution safety catch holders. Previous to the design of these devices, a number of porcelain cut-outs or ordinary safety catch holders of large capacity were used. As the capacity of the ordinary cut-out or safety catch holders was not sufficient to meet all requirements, the construction of a special device became necessary to carry the heavy current and distribute it to the various requisite points through the building. The centre of distribution safety catch holders, illustrated in the accompanying engravings, Figs. 1, 2, 3 and 4, were the outcome of this necessity.

Each branch of the device has a capacity of 250 amperes, and thus one of the appliances can be used where formerly several appliances had to be employed to effect the same end, the saving in cost of construction, and improvement in general appearance being a natural sequence. These devices are mounted on slate bases. The lugs are so constructed that they can be easily detached from the appliance, the necessary wires soldered in them, and they can then be returned to their places and screwed fast.

Provision is made of a small plug which, when inserted in its place carries the current around the safety catch when required. This short-circuiting plug is not intended for use for an extended period of time, and is only employed when changing the fuses in order that danger from arcing may be obviated. If it is necessary to have light after one fuse has blown the use of the short-circuiting plug still leaves a single-pole protection on the line; but as one plug only is furnished with each device, it would be impossible to have more than one safety catch short-circuited at one and the same time. The thumb screws are provided with large flat heads in order that they may be operated by hand, pliers or a monkey wrench. The specially designed washer under the head rises with the screw without turning on it, and the annoying operation of raising the washer with a screw-driver is eliminated.

The centre of distribution safety catch holder need not be set up outside of the dynamo-room, nor where the meter is attached to the street service, as it is frequently necessary to run two or more separate mains from this point to sub-centres of distribution in other parts of the building at which points these appliances could be placed.

These safety catch holders are made in four sizes, namely, two for the 2-wire system and two for the 3-wire system, for two and for three branches.



FIGS. 1, 2, 3 AND 4.—EDISON CENTRE OF DISTRIBUION SAFETY CATCH HOLDERS.

THE BALL ENGINE IN THE WARRENTON, MO., PLANT.

THE following letter has been received by the Ball Engine Co., of Erie, Pa.:

> WARRENTON ELECTRIC COMPANY.
> WARRENTON, Mo., April 18, 1892.
>
> BALL ENGINE CO., Erie, Pa.
> *Dear Sirs:*
>
> We started the engine purchased from you for our electric plant, last night, and the way it moved off was beautiful to behold. It is certainly a very fine and powerful piece of machinery. No vibration, no noise; in fact, and in short, it is perfect in every part and way. The satisfaction it gives is a pleasure to us, and must be gratifying to you.
>
> Very respectfully,
> C. E. PEERS,
> President.

"CANVAS JACKET" AND "FLEXIBLE CONDUIT."

THE ELECTRIC APPLIANCE COMPANY of Chicago are meeting with considerable success in the sale of "Canvas Jacket" wire and "Flexible Conduit" and have taken several nice orders for both. The trade, they say, are beginning to recognize the merits of the flexible conduit for interior work, on account of the ease with which it can be installed, as well as its qualities as an insulation. It is also being used largely as a substitute for hard-rubber tube in running wires through outside walls and partitions. The peculiar canvas weave used in covering both the wire and the conduit is remarkably effective and produces an insulation that it is claimed is well nigh waterproof as well as weatherproof. The insulation is made of the same material used in the heaviest tent canvas. The waterproof qualities of the wire are largely increased, however, by a liberal application of compound, thus producing an insulation far superior to anything that can be secured, it is said, by the braiding process.

LARGE POWER FROM A SMALL AMOUNT OF WATER.

THE PELTON WATER WHEEL CO. have recently furnished the Commercial Mining Co., of Arizona, a power plant, which affords a good illustration of the extraordinary results that can be obtained from a small quantity of water under a high head as also the estimate of value placed upon water-power where so large an outlay is made for a comparatively small amount of power. This plant consists of a 4-foot Pelton wheel which runs under a 1,200-foot head at 699 revolutions per minute developing 45 h. p. using a nozzle tip $\frac{58}{100}$ of an inch in diameter. Also a 24-inch Pelton wheel running under the same head at 1,380 revolutions developing 20 h. p. with a nozzle tip $\frac{35}{100}$ of an inch in diameter.

These wheels run a concentrating and smelting plant including rock breaker, blowers, pump, etc. The pipe line is 20,000 feet in length, the upper end being 6 and 5 inch casing and the lower end 5-inch lap-weld pipe. All the water supply that can be counted on during the dry season is a flow of about 30 cubic feet per minute. The large expenditure here made in pipe line for results obtained will indicate the advantage that water-power has over steam under much more unfavorable conditions than generally exist in such places.

THE NEW "A. B. C." CATALOGUE.

THE new "A. B. C." catalogue is just out. It is a book of over 270 pages, handsomely bound and contains prices and descriptions of almost every article required in the construction and operation of electric light, power and railway plants. Part of the book is devoted to railway appliances and shows a number of insulating devices and other specialties, which will be kept in stock at the New York store.

From an examination of this book, it is apparent that there have been during the past month many novelties brought out in the line of electric light fittings and fixtures, about 50 pages of the catalogue being devoted to new goods.

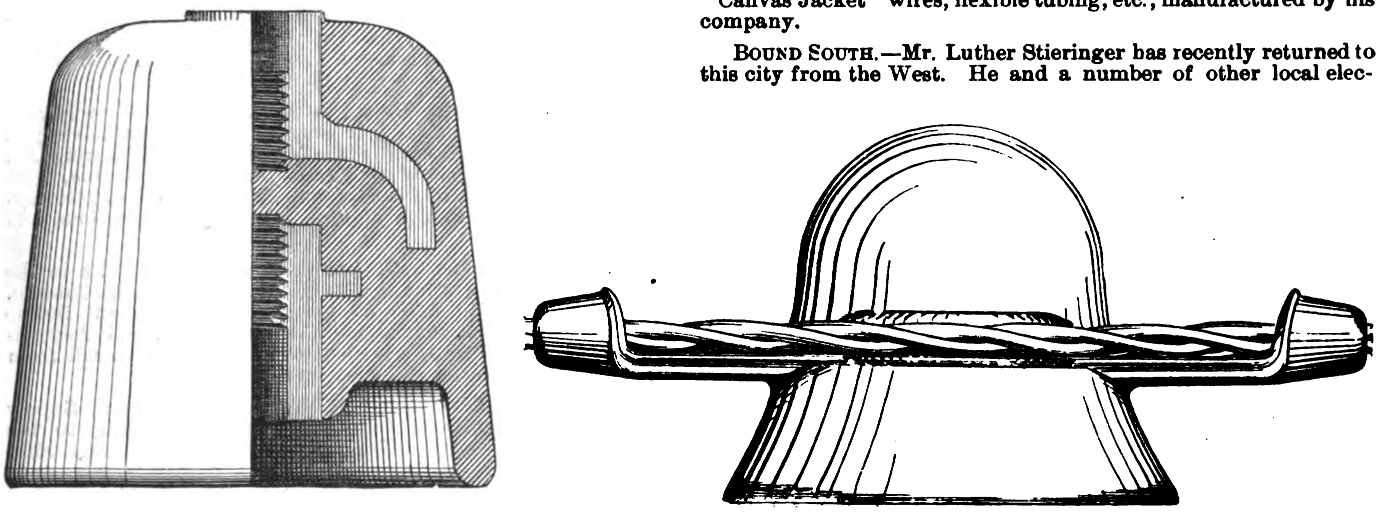
The subject of fan motors is given special prominence in this catalogue, several new forms of machines being described; among them are a $\frac{1}{10}$ horse power motor and fan for 110 volts, direct current, which appears to be one of the most compact outfits of the kind yet put on the market. The catalogue also describes a new alternating fan motor, which has several advantages, and on account of its high efficiency is likely to be largely called for by stations using the alternating system.

THE DETROIT ELECTRICAL WORKS IN THE WEST.

One of the most active and progressive of the newer Western communities is Sioux City, Ia., which has always been quick to show an appreciation of the good qualities of electrical inventions and apparatus. It is very proud of its electric railways, and will now hear of nothing but the best for further work in that line. An evidence of this is given in the placing of its contract by the Sioux City & Leeds Electric Street Railway. The officers of this road have been making a personal investigation of electric railway work all over the country, and were extremely critical in their point of view. Such being the case, the Detroit Electrical Works, of Detroit, Mich., may well feel pleased and highly complimented at capturing a contract from this road for six miles of overhead construction, and five 40 h. p. motor equipments with car bodies, trucks, etc., complete. It is understood that the apparatus is wanted as soon as possible, and the increasing facilities of the Works will enable a prompt execution of this and a number of other large orders recently received.

THE "ROUND TOP" AND "SALEM BELL" TROLLEY LINE INSULATOR.

We illustrate this week two new forms of trolley line insulators, now being manufactured by the Johns-Pratt Company, of Hartford, of which the H. W. Johns Manufacturing Company, of New York, are the selling agents. Fig. 1 represents the "Round Top" insulator, specially designed for the most substantial work. It consists of a metal shell throughout, with projecting lugs for the span wire. This outside shell is filled with moulded mica insulation, which surrounds the central metal nub, which carries a $\frac{5}{8}$ inch bolt. The edge of the skirt is turned down over the insulation, and the whole insulation is anchored in such a way that it cannot be damaged by the most severe handling, or by the accidental concussion of the trolley wheel, should it slip off the trolley wire. Fig. 2 represents the "Salem Bell" insulator also used for a straight trolley line insulator. This insulator is very similar to their regular line insulator, but as will be seen has one important improvement, in the nub or receptacle for the suspending bolt both top and bottom. This nub has been increased in length, and counterbored so that the screwed part does not take the whole of the side strain but is relieved by the bolt fitting snugly into the counterbore. It has been found that the weakest part of the bell insulators was at the point where the screw entered the metal nub, and experience has shown that this weakness is entirely overcome by this change, and altogether prevents any danger of the threaded screw from breaking. The top nub is counterbored $\frac{3}{8}$ inch and the bottom one $\frac{5}{8}$ inch, which makes the shape of the insulator a little longer than the old one, but not so great in diameter, the total weight being about 18 ounces.



Figs. 1 and 2.—The "Round Top" and "Salem Bell" Insulators.

GHEGAN'S IMPROVED DUPLEX.

In our issue of April 6, we described a new duplex system of telegraphy invented by Mr. J. J. Ghegan of this city. We are now glad to inform our readers that full details can be obtained from the inventor at the office of Messrs. J. H. Bunnell & Co., 76 Cortlandt street.

The system should prove of especial value in cases where a number of way stations are operated upon a single line, as is the usual practice in railway work, permitting, as it does, the sending of two messages in the same or opposite directions at the same time.

NEW YORK NOTES.

West Troy, N. Y.—The new board of electric light commissioners have held their first meeting and perfected their organization by the election of C. H. Fort as president, and Clinton Robinson, secretary. A general presentation of matters pertaining to the system was had, and with the assistance of Village President Royers, a thorough review of the present equipment and its needs was made. The commissioners will inspect the plant and service at once. A thorough revision of methods now in use has been determined upon, and will be of benefit to the taxpayers. It is proposed to secure sufficient additional lamps so as to have with those recently purchased a first-class light on every pole in the village, and a reserve of ten lamps for repairs and emergencies.

The Watervliet Railway Company of Albany, N. Y., are contemplating extensive improvements. The track from Livingston avenue, Albany, to the baseball grounds is to be rebuilt as well as the track from State street to South Ferry. The track in West Troy is also to be relaid. Forty new cars of 20 h. p. each have been ordered to replace the present ones of 15 h. p., also ten new summer or open cars. The power house at North Albany will be abandoned, and the company will equip its South Pearl street station with two new 500 h. p. dynamos.

Mr. Herbert H. Brooks, general manager of the American Circular Loom Co., of Boston, spent a few days in the city last week. While here Mr. Brooks completed arrangements with the firm of Doubleday & Mitchell whereby they will act as agents for "Canvas Jacket" wires, flexible tubing, etc., manufactured by his company.

Bound South.—Mr. Luther Stieringer has recently returned to this city from the West. He and a number of other local electricians are packing their traps now for North Carolina, where as capitalists and sportsmen they have large interests to look after and get fun out of.

J. Jones & Sons, 602 West Twenty-second street, announce that prospects are very bright for an enormous business. Large orders have been received by them recently for various goods, but the bright, particular star of their trade is the bell which they make with a dust-proof contact protector. This device literally speaks for itself, as, in spite of its large sales, it has not been pushed at all, but is sold entirely on its merits.

Fitchburg Engine Co.—The recent sales reported by the Fitchburg Engine Co. are three 150 h. p. tandem compound high-speed engines to the Hull Electric Light Co., of Hull, Mass.; one 75 h. p. slow-speed horizontal engine to Noble & Cooley, of Branville, Mass. They have also just completed the installation of, and have started a 75 h. p. engine for Healy & Co., 51st street and Broadway, and still another at the Union League Club, this city.

The Storage Battery Supply Co. have removed their works from 158 West Twenty-seventh street to the northeast corner of Twenty-third street and First avenue.

NEW ENGLAND NOTES.

Massachusetts Electrical Engineering Company, of Boston, have sold all the machinery and material used in the manufacture of fuse wire, together with the good-will of the business, to the Shawmut Fuse Wire Company, of 85 Water street, Boston, This company has been organized expressly for the purpose of manufacturing fuse wire and links of the highest grade and will have every facility for filling orders in a prompt and satisfactory manner. All the wire and links which they manufacture will be tested, as heretofore, at the laboratory of the Massachusetts Electrical Engineering Company, and a certificate of test signed by them will accompany each spool of wire and lot of links sold. The Shawmut Fuse Wire Co. will hereafter conduct the entire business, and will furnish these well-known fuses at the same prices as heretofore for the present, and guarantee in every way the same thorough reliability as before. Mr. Russell Robb is manager of the company and has had an extensive experience in this particular branch of business, so that customers may place their orders with the same confidence as before.

Mr. Levi Cofren, who has been for several years connected with the Pettingell-Andrews Company, of Boston, has recently been appointed general traveling agent for New England and New York State of the Washburn and Moen Manufacturing Company, in their insulated wire department. Mr. Cofren has made a specialty for some years of the insulated wire business, and is particularly well adapted to this line of trade. He leaves the Pettingell-Andrews Company with the best of good wishes, and is sure to achieve success in his new and broader field, as he has the respect and good-will of hosts of friends in this section of the country.

The Johns-Pratt Company, of Hartford, are busily engaged manufacturing the insulating line material for the Philadelphia Traction Company, of Philadelphia, Pa. This order comprises the line insulators for the span work, together with the strain insulators, centre pole bracket arm insulators, guy insulators and feed cable insulators. The Johns-Pratt Company are exceedingly busy both in the manufacture of their vulcabeston and molded mica specialties, and have now got their factory in first-class running condition, turning out both kinds of goods in large quantities.

The John Becker Manufacturing Company of Fitchburg, Mass., encouraged by the success which has been achieved by their vertical millers Nos. 1, 2 and 3, have decided to manufacture still another size which will be called their No. 4, and which will be capable of comparatively heavy work. The success which has attended the introduction of the Becker milling machine has amply proven that the vertical spindle millers are now being recognized as superior to horizontal millers for many purposes.

Mr. R. F. Ross has brought out a monthly paper called *Electrical Progress and Development*, as a successor to *Modern Light and Heat*. It is his intention to devote his new journal strictly to electrical work in New England, a decision that seems wise considering how active the field is and how well known in it Mr. Ross is. The paper is neat, newsy and well printed, and if there is any saving virtue in nerve, grit and perennial good nature, Mr. Ross will "get there" in great shape.

The Iona Manufacturing Company, of Boston, has recently been organized with Mr. Norman Marshall, president, Mr. H. P. Stanwood, treasurer; Mr. H. M. Nicholls, secretary; Mr. S. L. Whipple and Mr. John C. Holman, as directors. The capital stock of the company is $15,000, and it is their intention to go into the manufacture of general electrical supplies and specialties. The Redding Electric Company, of Boston, will act as sole selling agents.

The W. S. Hill Electric Company, of Boston, have issued a revised price list of their extensive line of electric switches. Their motto is "best quality—lowest price," and they aim to maintain the high quality of the goods for which they have already earned a wide reputation.

J. H. Horne & Sons Co. have decided to build a new machine shop 64 feet wide by 107 feet long and have placed the contract for same with the Berlin Iron Bridge Company, of East Berlin, Conn.

WESTERN NOTES.

H. W. Caldwell & Son, sole manufacturers of the improved "Charter" gas engines which are built for operation by gasoline, coal gas or natural gas, have issued a handsome catalogue of their engines which gives full particulars of various methods of operation and a great many highly valuable details regarding their working in general. The catalogue is handsomely illustrated with views of their engines showing details and contains a short and clear description of the various parts. These engines are rated in actual horse power and are of the very highest efficiency and best workmanship using only the gas in exact proportions to the amount of work they may be doing. They are very reasonable in price and especially adapted for running dynamos and can be used without any counter-shaft, being belted direct to the machine and giving a perfectly steady light, which is quite a remarkable achievement. The cost of running the improved "Charter" gas engines with gasoline at 10 cents per gallon is stated as being one cent per hour for each indicated horse power.

Mr. Eugene A. Erich, consulting and contracting mechanical and electrical engineer has been appointed general Western representative of the Waddell-Entz Electric Company, of New York. He has opened a temporary office at 438 Rookery but will move into the Monadnock Building about May 15.

Kohler Bros, the Western agents for the Eddy Electric Manufacturing Company, owing to lack of room in their present quarters at 341 Rookery, will remove May 1 to a handsome suite of offices at 1417-1418 Monadnock Building, corner Jackson and Dearborn streets, Chicago. Their business in motors for the past year has been very large and is continually increasing, and they are now equipped with facilities to carry a large stock of machines on hand and to handle their growing business more expeditiously.

The Lunkenheimer Brass Mf'g. Co., of Cincinnati, O., are preparing for the World's Columbian Exposition a most elaborate display of their popular specialties in valves, sight-feed lubricators, oil and grease cups, etc. They will also exhibit a complete line of brass and iron goods, besides some novelties in steam whistles and sight-feed lubricators. They report business exceedingly brisk, being crowded with orders for their numerous specialties and receiving large contracts for special work for United States cruisers.

The Electric Appliance Company continue to receive the strongest possible testimonials from users of Paranite wire all over the country to the effect that it successfully stands the severest tests to which it has been put and is proving entirely satisfactory where other wires have failed. They feel very much encouraged at the outlook for spring business and are rapidly pushing Paranite wire to the front.

Mr. W. S. Reed, consulting and contracting engineer, has opened an office also at 1222 Monadnock Building, where he will devote his attention to furnishing plans and specifications and supervising construction of all kinds of electrical plants, waterworks or other engineering work. Among his latest work is equipping the Harvey Transit Co., of Harvey, Ill., with waterworks, electric lights and railway plant.

The New Equitable Building at Des Moines is to have a very complete electric light installation. Contracts have just been placed with the Chicago office of the Pond Engineering Co., for one 25 and one 60 h. p. Armington & Sims engine, with foundation boxes. The Pond Company are also to deliver and erect these engines in Des Moines, with pipe connections and foundations.

Mr. Ernest Hofer, well known in electrical circles in the West, has opened an office at 1,222 Monadnock Building, Chicago, where he will handle a line of specialties, among them Bishop wires and cables, Electrix sockets, switches, etc., and Pennsylvania incandescent lamps. He will be glad to receive a call from his many acquaintances and customers.

The Western office of the Electric Construction and Supply Company has removed from the Phenix Building to the Unity Building, Chicago. The latter is one of the nicest office places in the city.

Mr. J. S. Gustin, formerly with the Electric Merchandise Company, of Chicago, as purchasing agent, has accepted a position in a like capacity with the Railway Equipment Company, of Chicago.

Mr. J. T. Macartney, recently traveling salesman for the Electric Merchandise Company, has resigned his position and has accepted a similar one with the Railway Equipment Company.

The Railway Equipment Company have just received an order for all the line equipment for the extensions to be made by the West End Street Railway Company, of Rockford, Ill.

WASHINGTON NOTES.

The Washington Construction Company, of Washington, D. C. (Messrs. Pardoe and Messner), have the contract for the lighting of the city of Lewisburg, Pa., with arc and incandescent lights. Mr. Pardoe is now on the ground constructing the plant. They expect to turn on the arc lights by the first of June. This same firm is also wiring the Union Building, of Washington, D. C., which is to be occupied by the City Post Office until the new one now building by the Government is completed. It is the largest piece of incandescent wiring ever done in the city of Washington. Out of five wires submitted, Bishop was selected.

The C. and C. Motor did a wonderful piece of work again a few days ago. The Star Newspaper Building, of Washington, D. C., had its entire steam plant destroyed a week or so ago. They had on hand a 20 h. p. C. and C. motor for just such emergencies. The motor itself had a very narrow escape from being burned, beside being thoroughly drenched with water. Yet the following day the motor was put in service and up to this date has been doing an actual 24 h. p. work for five hours a day.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

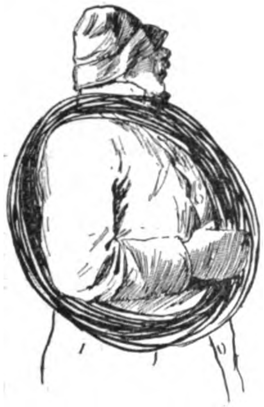
VOL. XIII. MAY 4, 1892. No. 209.

LONG-DISTANCE TELEPHONY.—I.

BY

Herbert Laws Webb

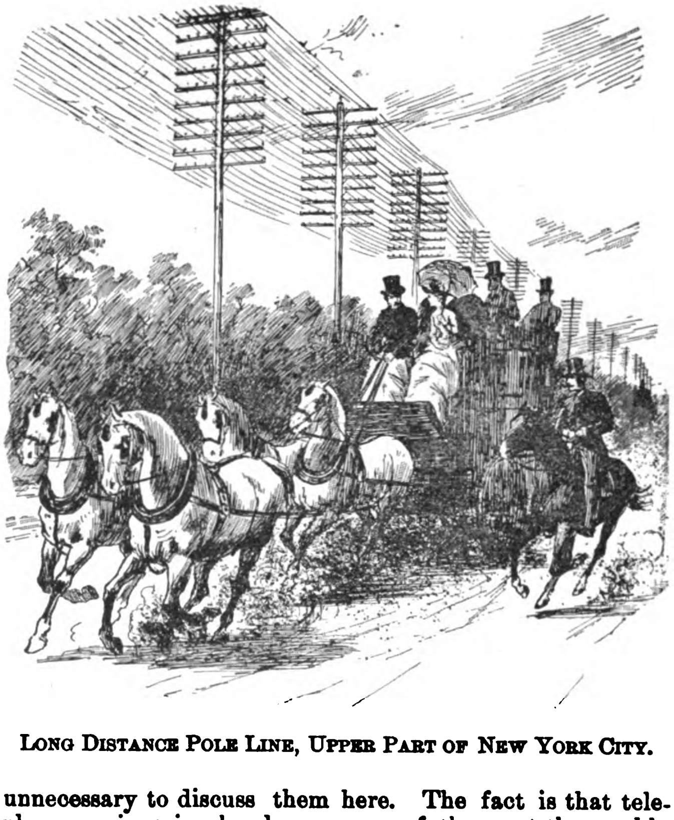
I.



In the introduction of any fundamental invention or discovery into the great field of commercial electricity it would need a bold and long-sighted prophet to foretell the developments of which that invention might be capable, the refinements and improvements in itself and in the accessory and auxiliary appliances with which a new thing soon becomes surrounded, and the complicated systems and methods which are evolved and built up as its working is rapidly extended. The incandescent lamp, when it emerged, a practical instrument, from the laboratories of the various inventors who invented it, hinted nothing of the revolution in dynamo building that it was to bring about, nor of the numerous beautiful measuring instruments that it was to call into existence, nor of the study of the heating of conductors and best methods of distribution that it was to give rise to, nor of the acrimonious discussions before the scientific societies and in the technical journals that it was to provoke, nor of the thousand and one ingenious appliances that were to be invented to add to its economy, safety and trustworthiness. So with the telephone. When Prof. Bell produced his speaking telephone 16 years ago who was there that thought of multiple switchboards, of 100-wire underground cables, of huge buildings planned out from basement to roof to serve as telephone exchanges, and what wild dreamer would have dared to prophesy daily business talks between New York and Boston, Buffalo, Pittsburgh or Cleveland?

Long-distance telephony has within the past few years been brought almost to the level of an exact science. It is an exact science in so far as whatever it attempts to do is done well and the results are assured beforehand, but it would be by no means wise to attempt to define the limits of the transmission of speech by telephone. So much has been done in improving the apparatus employed and in the construction and arrangement of lines that distances considered impossible a few years ago have been exceeded without any difficulty. However, we do not wish to discuss here what can or cannot be done by the telephone from the scientific point of view, but rather to describe just what it does commercially, and how.

The American Telephone and Telegraph Company, colloquially called the Long-Distance Company, has been engaged for the past five or six years in developing interurban telephony. Starting with comparatively small beginnings the long-distance telephone system has reached a magnitude that few people except those who are engaged in telephone work or who are users of the telephone have any idea of. This development has been attained by sound scientific work in every detail of instrument and line construction and by energetic business management, which have resulted in the building up of an industry that is one of the great achievements of commercial electricity. The actual development of telephony from both the electrical engineering and business standpoints has not been so closely followed by the technical press as that of the other great industrial applications of electricity. There are various reasons for this scarcity of telephonic literature, but it is unnecessary to discuss them here. The fact is that telephone engineering has become one of the most thoroughly scientific divisions of electrical work, and its application is exemplified in the most striking manner by an inspection of the vast plant of the long-distance telephone system. From the business and commercial point of view the subject will be found equally interesting, because the long-distance telephone service offers to business men facilities which cannot be given by any other kind of communication.

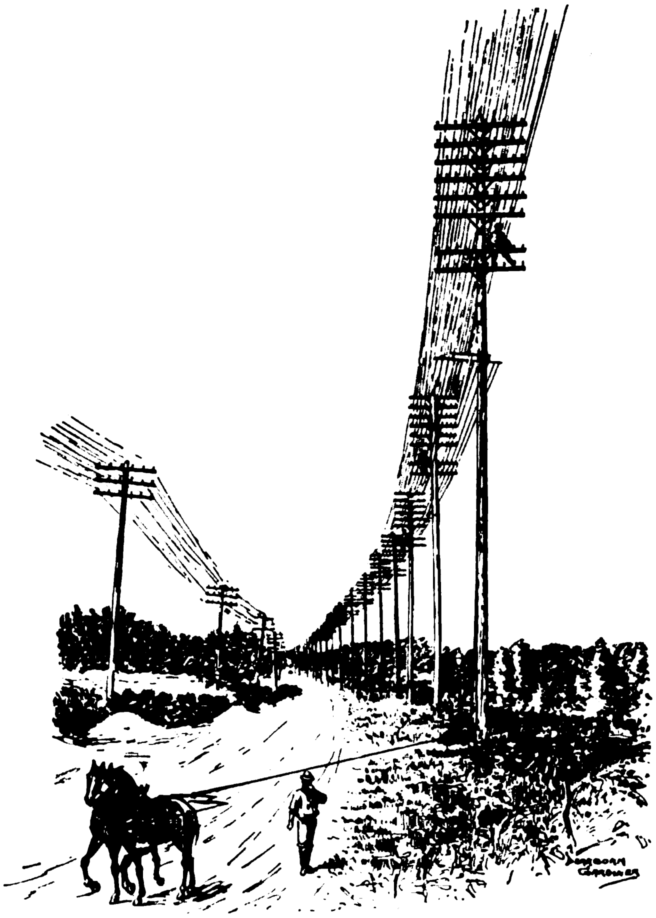


LONG DISTANCE POLE LINE, UPPER PART OF NEW YORK CITY.

II.

Even when the success of local telephone service was abundantly assured, some little time elapsed before interurban telephony was seriously attempted. It was found early in the career of the telephone that conversation could be maintained over lines 40 or 50 miles long, but from this to establishing communication between various towns as a commercial undertaking was a very long step indeed. An early instance of the recognition of long-distance communication as a distinct branch of telephony occurred in 1881. In November of that year, Gen. C. H. Barney, general manager of the Inter-State Telephone Company, issued a circular calling attention to the advantages of a projected ex-territorial exchange between Boston and Providence. This circular described the proposed method of communication in the following terms:

"A limited number of parties in Providence and Boston, who have frequent occasion to communicate with each other, will be formed into an exchange, a subscription to which entitles any subscriber in Providence to talk with any subscriber in Boston, or *vice versa.* A call bell, telephone and transmitter, all of the latest patterns, will be placed on the premises of each subscriber, and connected by a *metallic circuit* with central operating tables in Boston and Providence, which tables will be connected with each other, also on a *metallic circuit.*


ELEC. ENGR. N.Y.

STRINGING TEN TELEPHONE WIRES AT A TIME.

"Thus, any subscriber in one city can quickly be connected and talking with his correspondent in the other city *on a complete metallic circuit, ensuring a perfectly quiet line,* free from all sorts of induction or earth currents, with no possibility of being disturbed by the conversation of others or of having your own conversation overheard by them. No condition of the atmosphere and no trouble short of an actual breakage of the line can interfere with the perfect working of this system.

"Each subscriber has, practically, *a private line on a metallic circuit;* the only perfect system of telephony yet devised."

It will be noticed that in this letter special stress is laid, by italics and careful reiteration, on the importance of using a metallic circuit and the perfectly quiet line which resulted. A metallic circuit was a *rara avis* in those days and even the meaning of the term was scarcely understood. It is related of a young lady operator at Providence that on speaking over the line to Boston she expressed surprise at finding it so quiet in comparison with the noisy, buzzing, rattling grounded circuits that she was accustomed to deal with. On asking the reason she was told from the Boston end that they had the line "fixed on a metallic circuit." "Well, I only wish you could send me one over here!" was the remark she made.

A complete metallic circuit, ensuring a perfectly quiet line, naturally strikes one as it did the pioneers of the Boston-Providence line as being the first desideratum of long-distance telephony.

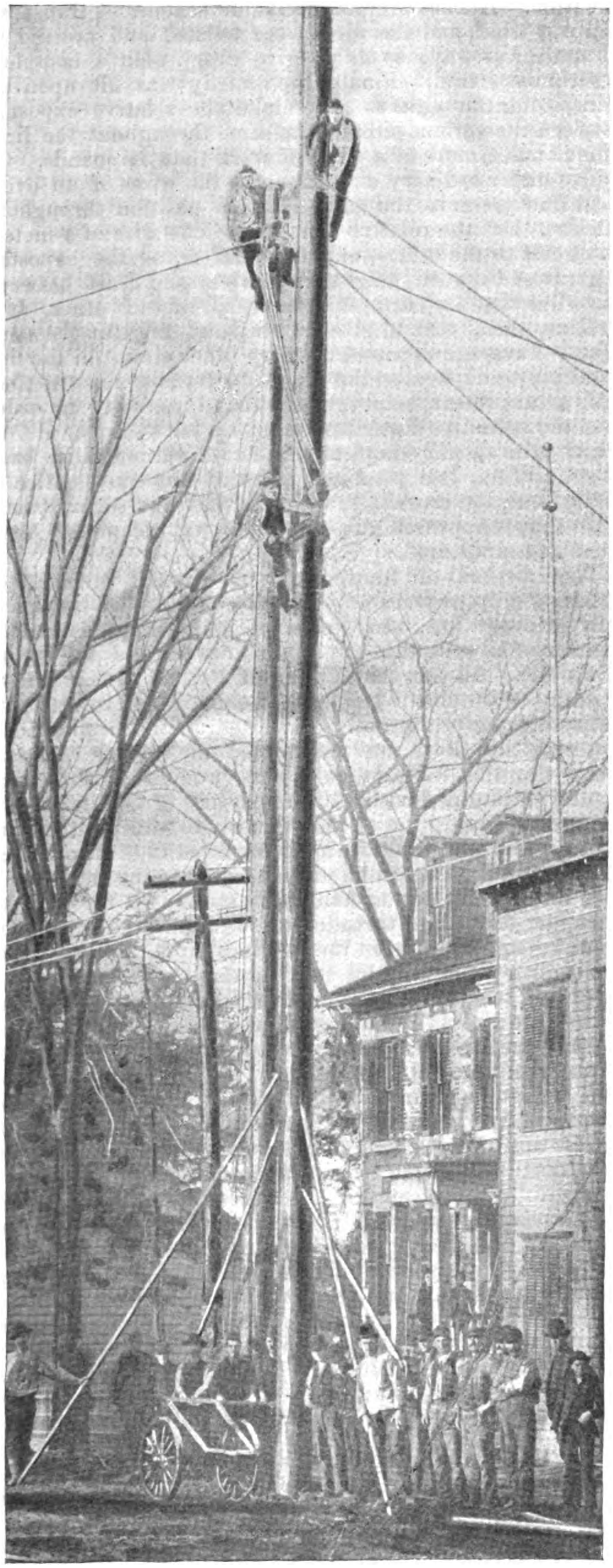
But there are many other important points connected with the establishment of a system on a large scale and even the metallic circuits themselves, when congregated together in close proximity, were found to disagree with each other and to need very careful treatment to secure perfectly quiet lines. As to the transmitting and receiving instruments, operating apparatus, central office equipments and the various details which go to make up a complete line, problems without number have been developed in connection with each and every one of them.

By attacking and solving these problems the long-distance telephone service has been brought up to its present state of matchless efficiency, when it provides talking wires between towns over 600 miles apart and maintains them intact during storms which hopelessly disable the telegraph lines.

It was not until the year 1884 that the project of establishing long-distance telephone communication in a systematic manner took definite shape. Previous to that time trunk lines had been erected and successfully worked between towns fifty miles apart and some experience had been gained. This was not seriously considered long-distance work, and when the American Telephone and Telegraph Company was formed its plans were laid out on a much more ambitious scale. The first line built by the company was between New York and Philadelphia, a distance of about 100 miles. This line was completed in 1885 and more information about the conditions required in long-distance telephony was obtained from it than any amount of text-book or theoretical study could possibly afford. So little was known about the working of long telephone wires at that time that the results obtained from the Philadelphia line were a complete revelation in many ways and in bringing it to the point of successful working the study of scientific telephone engineering received a marked and lasting impetus.

III.

From the very first the Long-Distance Company has set itself a high standard of overhead line construction. It was determined at the outset that nothing should be left undone in this direction to ensure the best results that good material and first-class workmanship and supervision could give. Every line is built according to rigid specifications, which contain a full description of every part of the material to be used and explicit instructions as to the manner in which the work is to be done, allowance being made for almost every imaginable condition that may be met with in building a line across country. The wire, of course, is hard-drawn copper, the standard size being No. 12 B. S. G. (.104 inch diameter) having a resistance of 5.2 ohms to the mile. All joints in the wire are made with the well-known McIntyre sleeves which make a thoroughly strong joint mechanically and give perfect electrical contact. In building a new line the wires are strung with great rapidity. Ten wires are put up at a time. The coils of wire are mounted on revolving drums placed in line near the first pole; the ends of the wires are attached to a bar which is drawn along by a team of horses. In this way over seven miles of wire, that is, ten wires each three-quarters of a mile long, can be strung up over the cross-arms in a very short time. A lineman is stationed on each pole to lift the bar over the top of the pole as it comes along; if the wires are drawing over a lower cross-arm the bar can be taken apart so as to pass the pole. The wires lie on the cross-arms, the insulator pins keeping them in place; when the wires are all drawn out the linemen proceed to stretch them up and tie them to the insulators.



Erecting a "Long Distance" Telephone Pole.

The poles are generally of live cedar or chestnut and are carefully selected so as to admit only the very soundest material. A special point has been made of using tall poles so as to carry the wires clear of trees and other wires; up to quite recently no poles less than forty feet long have been used on any line and in many places poles twice this length have been erected, sometimes for a considerable distance. It is a standing rule that the lowest wires of a long-distance telephone line shall clear all obstructions by at least six feet. The practice of using very tall poles, however, has lately been modified, as it has been found that a shorter, stiff pole gives better results; with a long pole the weight of the wires and cross-arms has so much leverage that in stormy weather the poles are liable to be either broken off short just above the butt or else torn clean out of the ground. It has therefore been decided to build new lines with poles thirty-five feet long, set six feet in the ground. The cross-arms are of seasoned pine, ten feet long, and are fastened to the poles by long-fetter drive bolts and securely braced by two iron braces. Each cross-arm carries ten split locust pins for pony glass insulators.

In building a line the greatest possible care is taken to have the spans as even as possible; the length of the span does not exceed 130 feet on a main line carrying fifty wires, and an even shorter span is made for a heavier line. On curves the regular span is departed from and poles are placed closer together, but as soon as the line is beyond the curve the regular spacing is returned to. No pole is placed immediately in front of a gate or driveway nor within ten feet of a pole belonging to any other line. Every detail of pole-setting receives careful attention. On the straight, poles are set at least six feet in the ground and on curves at least seven feet. The holes are dug large enough so that the butt of the pole can be dropped straight in without any forcing, and when the pole is in position only one shovel can be used to fill in, the earth being thoroughly tamped down with three iron tampers at every step until the hole is completely filled with solidly packed earth. Where the ground is too soft for proper tamping a grouting composed of one part of Portland cement to two parts of sand mixed with broken stone is used to make an artificial foundation. In medium soft soil the pole is braced up or anchored by means of two pine planks about eight feet long, which are bolted to the pole just below the surface of the ground and give it a firm bearing. At all curves the poles are thoroughly guyed or braced, head or side guys being used as the conditions demand. A special point is made of keeping the line as level as possible, that is, of avoiding abrupt changes of level in the wires themselves; to this end the height of the poles is proportioned to the contour of the ground, tall poles being placed in dips and valleys and short ones on knolls and eminences.

IV.

The securing of rights of way is quite an important part of laying out a long-distance line. It is of course highly necessary to ensure that the line shall be free from all risk of intentional interruption, and great care is taken to consult and secure the consent of all property-owners and municipalities wherever requisite. All of this is done in the most business-like manner, formal agreements and contracts being drawn up regarding every right of way secured. The Long-Distance Company also buys the right of trimming trees wherever the branches are likely to interfere with the lines; occasionally the trees have to be bought outright in order to trim them sufficiently or remove them entirely so as to render the lines perfectly safe. It is a rule that the branches of all trees near the line shall be trimmed so as to clear the wires by at least six feet. By attending to all these details with minute care the company renders its lines as safe as they possibly can be made, both as regards intentional damage arising from disputes with property-owners and accidental contacts with overhanging trees, which would give rise to serious disturbances.

At all points of junction between the overhead lines and underground or submarine cables the terminal pole is surrounded with special safeguards, which are rendered necessary on account of the pull of the wires being all in one direction. An extra pole is set within 30 feet of the terminal pole in order to make a short span, taking off a great deal of the strain from the terminal pole; this pole is head-guyed to the terminal pole. The terminal pole itself is side-guyed in both directions and also either head-guyed or braced; in this manner it is rendered capable of bearing all the strain thrown on it and is made practically as solid as a rock. At one time it was the practice to fit double cross-arms on the terminal poles and to tie the wires to the insulators on both cross-arms, but this has been abandoned as it was considered that the weakening of the pole through driving so many large bolts into it more than counteracted the advantage of the double cross-arms.

By adopting these thoroughly sound methods of pole line construction and building all lines on strict engineering principles the Long-Distance Telephone Company has built up a plant of overhead wires which both for sightliness and efficient working has no equal probably in the world, certainly not in the United States, where overhead construction generally is of the flimsiest and most rough-and-ready description. It must be borne in mind that in running a large number of telephone wires for a long distance on a single line of poles the company embarked in absolutely pioneer work. Where other very long telephone lines are in use they consist generally of a single circuit only, or at most two. The difference between operating one or two metallic circuit telephone lines and operating 10 or 20 or 40 on the same line of poles is very great indeed and is a point that generally escapes notice. Such confidence, however, was felt by the officers of the company in the success of the plans they had drawn up that the first line built, that between New York and Philadelphia, was equipped with 26 wires, sufficient for 13 metallic circuits.

This line was arranged acccording to what was then known or imagined about long-distance telephony. It was supposed that with carefully constructed metallic circuits perfectly quiet lines would be obtained. At that stage of the art this was a fair premise. It had been shown before that with a well-insulated metallic circuit there was no trouble from outside interference and such a thing as telephonic induction between different metallic circuits was not suspected. It is always the unexpected that happens, however, and in this case it was found that a number of metallic circuits run in close proximity to each other could be quite as troublesome as a number of grounded circuits, or even more so. When communication was established between the two cities it was found that conversation between New York and Philadelphia could be had with perfect ease, but the disconcerting fact presented itself that talking being carried on over one circuit could be plainly overheard on any other of the 12! The induction between wire and wire was so effective that it was quite practicable to carry on a conversation from one circuit to another. The plan of transposing the circuits in the middle of the line was tried and although some slight difference was noticed the evil was still almost as great as at first and it was found quite impossible to open the line to public service until the problem of telephonic induction between metallic circuits had been satisfactorily solved and a corrective applied.

V.

This was done by undertaking an exhaustive series of practical experiments with a view to discovering the manner in which the disturbance was caused and the share of it which might be attributed to the different elements of the circuit. Naturally, transmitters, receivers, induction coils, and switching apparatus came in for thorough investigation, but the line was the object of most searching attention. Almost every conceivable scheme of transposition was tried, and the wires were twisted and crossed in all manner of ways so as to give every plan a complete experimental trial. Finally the remedy was hit upon by transposing the wires so as to make the relative exposure between the various circuits the same throughout the line. This is much more of a piece of work than it sounds. Of course under ordinary circumstances the wires of an overhead line preserve the same relative position throughout the line. But the relative exposure of one wire of a metallic circuit to the others, of course, differs, as the exposure is greatest between neighboring wires and least between the wires that are furthest separated from each other. It is obvious, then, that to give each wire of a circuit the same effective average exposure to every other circuit in the line materially complicates the work of overhead construction. This arrangement, however, was found necessary in order that the inductive disturbances set up between the different circuits should completely balance and neutralize each other. When this plan was adopted and systematically carried out, the cross-talk, which at first was so extremely plain that it appeared unconquerable, was completely overcome and eradicated.

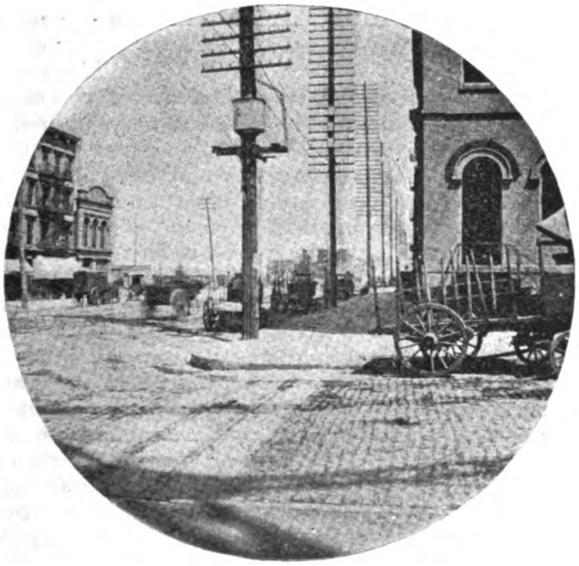
This method of transposing the circuits involves, of course, the preparation of a separate scheme of transposition for every line, the design of which depends on the number of circuits that the line is to carry and the length of the line. All this has to be carefully laid out before the building of the line is begun, as the directions referring to transpositions form an indispensable part of the specifications. Transposition poles are determined at regular intervals along the line. These poles are provided with special double insulators devised for the purpose of facilitating the change in the position of the wires where transpositions are made. The transposition insulator consists of two insulators threaded on the same pin. The lower insulator has a hole through the top and the pin extends up through it; the upper one is then threaded on the top of the pin, a good space being left between the two insulators. In order that the ordinary pins may be used for the double insulators, a threading tool has been devised for turning down the lower part of the pin to the required dimensions. When a circuit is transposed, the left-hand wire of a pair is brought to the upper insulator and then extended parallel with the cross-arm behind and around the upper right-hand insulator. The right-hand wire of the pair is taken to the lower insulator and then behind and around the lower left-hand insulator. The wires are tied to each insulator in the usual manner. The transposing of the wires is done in this manner during the construction of the line without cutting the wires, and the linemen have become so expert in this method of running wires that no difficulty is found in keeping up the standard of construction in spite of the complications introduced by transposing the wires at frequent intervals. When existing circuits have to be transposed the wires are dead ended at each of the four insulators, and the transpositions are made by connecting short pieces of insulated wire which are drawn tightly across the two wires to be transposed.

The transposition poles are set at intervals of 1,300 feet, or four to the mile, on all lines, but only a certain number of the circuits are transposed at each pole. When a circuit is transposed the relative position of the two wires which compose it is reversed, and this renders it neutral to certain of the other circuits on the line. At another pole other circuits are transposed and the process is kept up until neutrality is obtained between all the different circuits. The scheme of transpositions, of course, becomes more complicated as the number of circuits of which the line is made up increases, and the arrangement of the transpositions for a long line containing a large number of circuits is no simple task.

VI.

The twenty-six-wire line to Philadelphia having been brought to successful operation and the feasibility of long-distance telephony over a line containing a large number of circuits completely vindicated, further extensions of the system were made eastward from New York, through the New England States. The Philadelphia line was of the nature of a bold experiment, but so much valuable information was derived from it that in building the line to Providence and Boston the company planned its operations on a much more ambitious scale. The experience already gained showed conclusively that the most important factor of the entire system was the line. If the electrical conditions of the line were favorable no particular difficulty could be apprehended in providing efficient transmitters, receivers and operating apparatus. To secure favorable electrical conditions, apart from the scientific arrangement of the line for neutralizing inductive disturbances already described, the very highest grade of construction was absolutely necessary. This was adopted in the beginning and has been consistently adhered to throughout. The second great advantage which arises from the adoption of a high standard of line construction is the trustworthiness of the service, which is one of the most salient features of the long-distance system.

The maintenance of the long-distance telephone lines excels that of any known system of overhead electrical communication in the world. When the company started to build their main lines from New York to Boston and other New England towns a pole line was constructed to carry eighty wires, and this number of wires continued on a single line of poles for a distance of fifty miles out of New York. Telegraph men smiled and scoffed derisively, declaring that it would be impossible to talk without interferences over such a line to begin with, and further, that it would be impossible to keep all the wires in order for a single day. The line worked perfectly, as the system of transpositions devised for it took care of all inductive disturbances. As for the maintenance, the records show that on about two hundred days of the year not a single trouble occurs on any of the wires. It will be granted that for four thousand miles of wire this is a pretty good record and one that it would be hard to beat. One of the main lines between New York and Boston has forty wires, and the maintenance record of this line is equally good. During the severe storm which prevailed through the first four days of March of this year the ten thousand miles of wire contained in this line remained absolutely intact, without developing a single trouble of any sort. Such practical results as these show conclusively the value of paying the utmost attention to all details of line construction and maintenance.



A Long Distance Telephone Line in New York City.

Patroling the Long Distance Lines During the Great Blizzard, March, 1888.

It is well known that owing to the stable character of the long-distance lines the company is always able to give telephone service at times when the telegraph is hopelessly crippled. There have been many instances of this during the past few years; probably the most notable one was afforded by the famous blizzard of four years ago. For several days after that phenomenal storm the only direct communication with points outside of New York was had by means of the long-distance wires, and while telegrams between New York and Boston had to be sent via Ireland through the Atlantic cables, conversation by telephone was carried on between the two places with the same ease and regularity as during ordinary times. On many occasions since then the long-distance telephone wires have stood the business community, the newspapers and the railways in good stead, as the storms which play havoc with the telegraph lines seldom succeed in doing any serious damage to the stout poles and tautly drawn copper wires of the long-distance telephone system.

VII.

After having extended the system through Connecticut, Rhode Island and Massachusetts, providing several independent routes between New York and Boston, lines were built up into Vermont, New Hampshire and Maine. Next a main line was built up through New York State through Albany, Troy and Syracuse to Buffalo. Other lines were extended through the central part of the State and through Pennsylvania and New Jersey, joining all the principal manufacturing towns in the general system of communication. Southwest, lines were built to Baltimore and Washington, and finally operations were pushed directly westward through Pennsylvania and over the Alleghenies to Pittsburgh and Cleveland. Up to quite recently the line between New York and Buffalo was the longest telephone line used for regular commercial service in the world, the length of the circuit being about 450 miles. Direct communication is now often called for between Boston and Pittsburgh via New York, the circuit measuring over 600 miles and containing several miles of underground and submarine cable. The transmission between Boston and Pittsburgh is perfectly good, in spite of the great length of the circuit. By way of showing that the long-distance telephone system is capable of even greater feats than this, communication was recently had between Newark and Boston over a circuit upwards of a thousand miles long. This circuit was made up by connecting together wires going through Philadelphia, Pittsburgh, Erie, Buffalo and Albany; the experiment was thoroughly successful, as conversation was maintained over this extremely long line without any difficulty whatever. In view of such results as these it may reasonably be expected that by the opening of the World's Columbian Exposition Chicago and New York will be in direct telephonic communication.

VIII.

Although overhead wires of course make the most favorable line for telephonic transmission, owing to their low inductive capacity and comparatively low resistance in carrying a line across country and through cities, certain lengths of submarine and underground cable necessarily have to be included in the line. Wherever it is possible to do so, underground work is avoided, as a very short length of underground cable suffices to cut down the transmission to a great extent. This can readily be understood when a comparison is made between a line having a resistance of 5.25 ohms and a capacity of .015 microfarad to the mile and one having a resistance of 44 ohms and a capacity of .08 microfarad to the mile. Telephone cables have been greatly improved during the past few years and the inductive capacity has been lowered to a point that would have been considered impossible when the wires were first put underground. Three years ago the average capacity of the wires was .18 microfarad per mile; to-day underground cables are made containing one hundred wires in a pipe 1.875 inch in diameter with an average capacity of only .075 microfarad per mile. With all the improvements that can be made, however, underground cables must always constitute a serious obstacle to long-distance telephony. The only places where these cables must be used are the large cities, such as New York, Boston, Philadelphia and so on. The junction between the overhead lines and the underground cables is made generally on a pole, the cables being led up the pole and headed up in a tower consisting of a railed platform for the men to work on and a weatherproof box for the protection of the cable heads and lightning arresters. Insulated bridle wires are jointed to the overhead wires and cleated in regular order along the cross-arms to the pole which they follow down into the cable box where they are connected to the lightning arresters. The arresters are so arranged that the fuses can be removed for testing the line in either direction when tracing out troubles.

Submarine cables are even more objectionable than underground wires, because the waterproof insulation used for protecting the conductors has a much higher inductive capacity than the paper or cotton insulation used in underground cables. The capacity of a single mile of submarine conductor is about equivalent to that of twenty miles of overhead wire. Submarine crossings occur pretty frequently in the long-distance system, but fortunately the cables are seldom more than a few hundred feet long; the longest crossing is that of the Hudson River at New York City, where the cables are almost exactly a mile long. The plan of twisting the conductors in pairs to prevent inductive interference between the different circuits which has been so successful in underground cables, cannot be followed in the manufacture of submarine cables with rubber-insulated conductors on account of mechanical difficulties, but a special form of cable has been designed by the engineer of the Long-Distance Company in which the conductors are laid up in groups and the groups afterwards stranded together; this makes a convenient and compact arrangement of submarine conductors. The cables are led into small cable houses on each side of the river in which they are connected up to lightning arresters of improved design. The overhead lines terminate on a terminal pole just outside the cable house, and insulated bridle wires are jointed to the line wires and run down into the cable house and there connected to the line side of the lightning arresters. Periodical tests for insulation and copper resistance and inductive capacity are made on all cables belonging to the Long-Distance Company by members of the engineer's staff.

A style of cable which is peculiar to the American Telephone and Telegraph Company is that called "emergency cable." This is made up of fourteen waterproof insulated conductors twisted in pairs and laid up round a core of steel wires stranded together. The cable is served with an outer protection of tape impregnated with compound. This emergency cable is very strong and can be laid in almost any position, over housetops or strung upon the stumps of broken poles, or along the ties of a railway. Thirty miles of it are kept always in stock by the company for prompt temporary repairs of any line that may be interrupted by a fire or a storm of extraordinary violence. The cable is stored on reels which hold 1,500 feet each; these reels are designed to be taken in a combination baggage car so that they may be quickly sent to the scene of action, and a certain number of them are kept in readiness at various points in the system.

LEAD-COVERED CONDUCTORS.

The substitution of lead instead of zinc for coating or galvanizing conductors is advocated in an article in *L'Electricien*. Zinc has certain disadvantages—tendency to form an alloy, high melting temperature and tendency to flake. Lead seems to be preferable for certain reasons, and its application is similar to that of zinc. The objects are cleaned electrically, and immersed in an aqueous solution containing 10 per cent. of hydrochloric acid and 1 per cent. of hydrofluoric acid, heated to 50° C. in a vessel coated with lead. They are connected to one pole of a dynamo as anode, the lead coating constituting the other pole. After this preparation they are dipped into limewater of the same temperature, and then into an alloy of equal parts of zinc and tin in hydrochloric acid, which greatly favors the adherence of the melted lead into which they are then dipped. The process is economical and is not confined in its advantage to iron or steel articles, but may be used for chemical and electrolytic vessels. The iron or steel wires serving as protection in armored cables, it is suggested, might be advantageously treated by this method in preference to the ordinary galvanizing process.

"MUST HAVE IT."

The superintendent of the Haverstraw Electric Light Co. writes us: "I can hardly do without The Electrical Engineer. I have taken it for three years and have received from its pages much help and edification."

THEORETICAL ELEMENTS OF ELECTRO-DYNAMIC MACHINERY—III.[1]

BY

A. E. Kennelly

POTENTIAL DISTRIBUTIONS.

THE case in which the magnetic equipotential surfaces are parallel, equidistant planes is of considerable importance, on account of its geometrical simplicity and also of its practical applications. The gradient being everywhere equal and in the same direction, *B* is everywhere equal in intensity and normal to these planes within the limits of the distribution. This condition is termed a uniform field, and must necessarily be confined to limited portions of any magnetic circuit, when it is considered that all flux lines are closed curves, and cannot follow straight lines for even one-half of their total circuital length. On the other hand, even the most irregular and sharply curved fields can be divided into so great a number of small elements that each may be considered separately as a uniform field. The earth's magnetic field represented over the surface of a small model globe would appear to be far from uniform, but on the actual scale uniformity appears to exist, and *B* is constant (at any one moment, beyond the range of iron or iron ore) within several hundred feet of any locality so far as the most sensitive instruments can discern.

A uniform helix of wire was named by Ampere a solenoid. Strictly speaking the term only applies to a series of equal and parallel conducting rings arranged in close successive order round a common axis, but the difference between a closely wound spiral and the hypothetical arrangement is usually negligible in action. The field within an infinitely long solenoid carrying a current is uniform, the equipotential surfaces being planes normal to the axis, and dividing the interior of the solenoid into equal compartments.

If c be the C. G. S. current circulating in the solenoid, and n the number of turns per centimetre of length, nc will be the current turns per unit of length, and the distance between the successive integral equipotential planes will be $1/4 \pi nc$ cms. The gradient being one erg in this distance, its representative, the flux, will be $1 + 1/4 \pi nc$, or $4 \pi nc$ units of flux per square centimetre, and if the cross sectional area of the solenoid be a square centimetres, the total flux within it will be $4 \pi nca$.

While theoretical uniformity of field would only be attainable within an infinite solenoid, a very close approximation to uniformity is secured from solenoids of convenient practical dimensions if their length is great compared with their diameter. The flux becomes divergent in such cases towards the extremities, and as the length of the helix is reduced, the limits of practical uniformity are retracted and narrowed to the centre of the coil. The flux emerging from the extremities completes the external circuit by indefinitely extending contours.

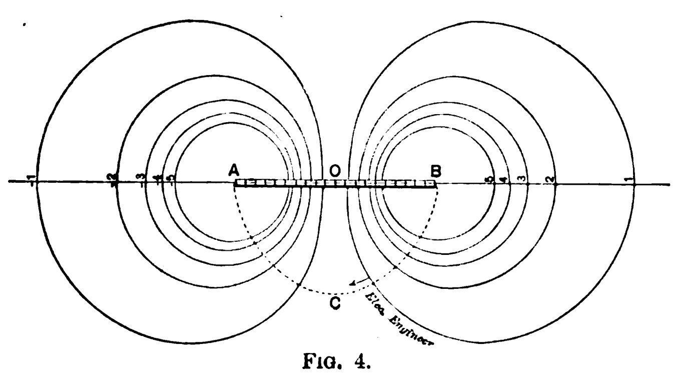


FIG. 4.

Fig. 4 represents a plane section through the axis of a solenoid A O B, and the ovals are the traces of a few of the equipotential surfaces that govern the external flux. If these could be rotated about the axis A O B a dumb-bell-shaped system of equipotential envelopes would be formed. The length A B being taken as 100 cms., and the C. G. S. current turns 100 per centimetre, the successive integral surfaces would be represented to scale from 5 ergs positive to 5 ergs negative, the central plane through O C, normal to the axis, being that of zero potential. The sectional area of the solenoid is also assumed to be one square centimetre for convenience. The flux is always at right angles to these surfaces on its passage down grade from B to A as indicated by a single dotted line A C B taken as one path at random out of the infinite number possible. Within the solenoid, the surfaces are very nearly planes, and the field very nearly uniform from the centre O to within ten diameters of the ends.

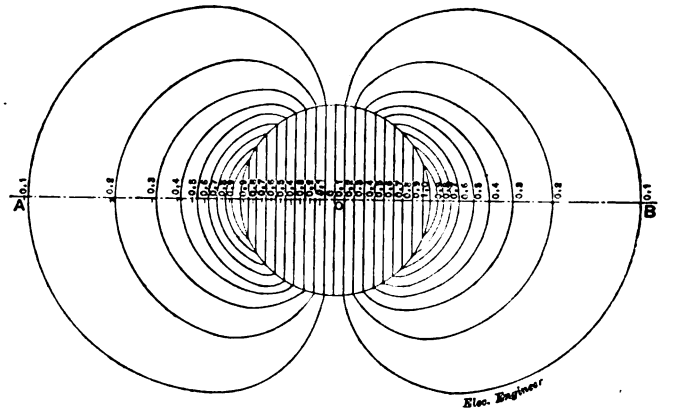


FIG. 5.

Another form of conducting surface which produces a uniform field within the entire space it envelops is Maxwell's ellipsoid. If an ellipsoid be divided into slices by equidistant planes normal to one of the axes, and the surface between each consecutive pair be uniformly wound with the same number of turns of conductor, so that the current turns round each slice are equal, the field within the ellipsoid will be uniform. The proposition applies to a sphere as a particular case. Fig. 5 represents a plane section through the centre of such a sphere and gives the traces of a few equipotential curves. The diagram if revolved about the axis A O B would generate a system of equipotential surfaces forming planes within the hollow sphere, and spheroidal envelopes external to it. If the diameter of the sphere be 20 cms. and the surface be wrapped with ten turns of wire per centimetre of axis, making 200 turns in all, a current of 0.002387 C. G. S. will establish to scale the surfaces represented; and generally, if nc be the current turns per axial centimetre, the potential of any plane through the sphere parallel to the windings, distant x centimetres from the centre, will be $\frac{4\pi}{3} ncx$, a value independent of the diameter of the sphere. The gradient will then be $\frac{4\pi}{3} nc$ ergs per cm. and this will be the value of *B* everywhere within the sphere.

This case of the uniformly wound ellipsoid seems to be the only one yet known that will produce throughout the interior of a conducting surface having any assigned finite magnitude a perfectly uniform field. The geometrical difficulties in the way of its accurate practical construction appear to have excluded its application from the purposes of measurement.

It is curious to observe that while in Fig. 4 there is an absolute discontinuity at the surface of the solenoid between the internal and external potential surfaces except at the centre o where the zero planes coincide without and within, in Fig. 5, at the surface of the sphere there is a discontinuity of direction only, and a continuity of numerical value. The surface continues with a sudden change in shape.

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[1] Copyrighted 1892 by A. E. Kennelly.

We have defined the potential as that quantitative property of a point in space, whose gradient is the vector flux intensity. There is, however, another and useful point of view from which the conception of potential can be regarded, and which has in reality prior claims to consideration so far as regards the historical development of the subject. The definition which follows can, however, be readily proved to be involved by, and equivalent to, the preceding.

The magnetic potential at any point, due to any magnetic body or system, is the work which would have to be mechanically performed solely against magnetic forces, in conveying a free unit north pole from an infinite distance up to that point, assuming that no other magnetic forces are active on the pole during the journey except those exerted by the body or system considered.

In other words, the potential of a magnetic element or system at a point is the potential energy between that system or element and a free unit north or positive pole there deposited; for, if left free to move in obedience to magnetic forces, the pole would commence to retreat and develop kinetic energy that would find its complete value in a culminating velocity only after having receded to an infinite distance. That final kinetic energy would be the potential of the starting point. That is on the supposition that the potential of the point was positive. If, on the contrary, the potential had been negative, the $+$ pole would not have retreated, but would have absorbed work, *i. e.*, developed negative energy during the passage; it would have been attracted by the body exercising potential influence and not repelled.

As a consequence of this relation, it is evident that if we move our ideal free north unit pole from a point whose potential is, say, 50 ergs $+$, to one whose potential is $+$ 75 ergs, we shall have to expend 25 ergs of energy in the process. The energy will be stored in the system potentially, and will be liberated on a return journey. The amount of energy is independent of the path selected between the points, provided that it is not linked with any current or magnet, or in other words that the path could be drawn tight into a straight line without cutting through any current or magnet. For if a rectilinear path expended 25 ergs, while another course diverged to execute one complete turn, in addition, round some current of c C. G. S. units, the work done in this passage would be $25 \pm 4 \pi c$ ergs, the sign depending on the direction of circuitation and of this current.

Also it is evident that no work would be expended magnetically on, or by, a pole constrained to move exactly over an equipotential surface. Whatever energy might be exchanged between the pole and its environment under those conditions would be altogether independent of the magnetic system, and would take place equally if that system had been suppressed. On this account a pole does no magnetic work in directly approaching or leaving an infinite rectilinear current alone in space, and a long straight current-conveying wire does not attract a magnet, for we have seen that the motion would be confined to some equipotential plane. But work would commence to be done, and energy commence to enter or leave the magnet so soon as the latter departed from the straight line of approach, and moved round the wire.

Mr. Frederic Nicholls, who is so largely identified with electrical interests in Toronto, has been elected to the presidency of the Athenæum Club of Toronto, a social and athletic organization of high order. The club has built itself a new house, which opened with great *eclat* on April 4.

RECENT IMPROVEMENTS IN QUADRUPLEX TELEGRAPHY.

BY

William Finn.

Numerous attempts have been made in the past to increase the efficiency of quadruplex circuits by the introduction of certain devices having for their principal object the neutralization of the "kicks" produced upon the neutral relay by the reversals of the distant battery. Many of these devices have been more or less successful in operation, though none can be said to have proved entirely acceptable under all conditions of working.

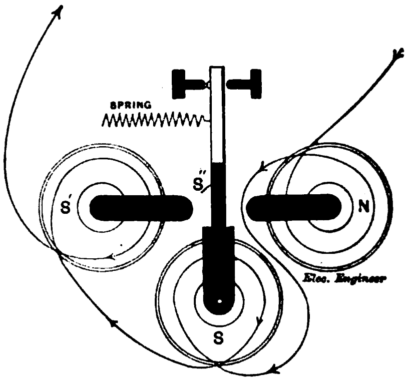
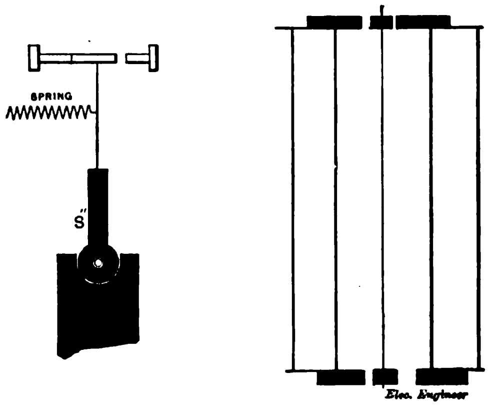


Fig. 1.—Freir Self-Polarizing Relay.

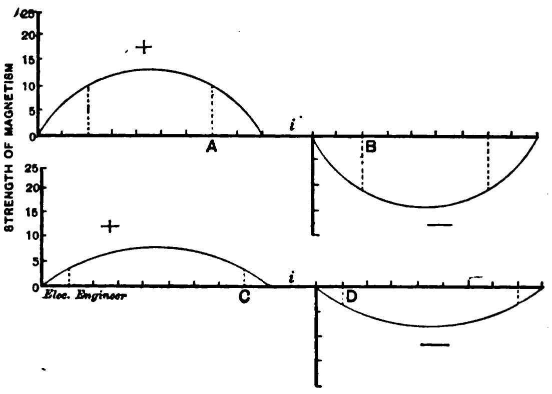
A relay has been recently invented by Mr. Samuel P. Freir of the Western Union Telegraph Co., in this city, which entirely obviates the necessity for any of those adjuncts, which have heretofore formed so conspicuous a feature of every long quadruplex circuit. The apparatus is called a self-polarizing relay, and consists essentially of three coils, Figs. 1, 2 and 3, one of which, S, is in connection with and magnetizes a soft iron armature S'', whose induced polarity alternates with every change in the direction of the received current. The other two coils N and S', respectively, attract and repel the armature, which merely responds to the "increase" of the distant battery, by moving in a certain direction only, regardless of the changes in the direction of the current. This will be apparent by referring to Fig. 1, which shows the winding of the coils to be such that the nature of the magnetism induced in the repelling coil on the left, together with that induced in the centre, or armature coil, is alike, but opposite in polarity to that created in the right-hand or attracting coil.



Figs. 2 and 3.—Freir Self-Polarizing Relay.

The success of the apparatus depends apparently upon its small "time constant"; or, in other words, upon the property it possesses of becoming actively energized by the exciting currents when they acquire a strength less in amount than that which they ultimately attain. It has no iron yoke like other relays, and the mass of its cores is otherwise diminished; so that the iron receives, and parts, with its magnetism very readily. The magnetism developed is comparatively feeble, though of sufficient intensity to affect the light moving parts of the instrument, without generating those strong counter E. M. F.'s in the coils, which in other relays retard the growth and decay of the incoming currents. The "interval of no current," which has been more or less regarded as the bugbear of the quadruplex system, is almost imperceptible in this relay; which strengthens the belief that the said interval has not in reality played so detrimental a part in the operation of quadruplex circuits as has been generally supposed. It would appear, on the contrary, that the high self-inductive property of the neutral relay has been the main cause of its inefficiency.

In a relay of considerable inductance, the magnetism developed at the very commencement of a current is of comparatively small value, owing to the retarding effects of the counter E. M. F.'s previously mentioned. Some time must, therefore, elapse after the current has been started, before the magnetization excited gains sufficient strength to attract the armature against the strong antagonistic force of its spring; and just as soon as the magnetism falls below that same value, the spring will tend to pull the armature away from the cores again. The period during which the armature will remain attracted by a current will evidently be augmented should the relay become responsive, when the magnetic intensity acquires a comparatively low figure. The interval of no current will then be so small compared with the length of time the current will remain *effective*, as to be hardly noticeable on the relay.



FIGS. 4 AND 5.

This appears to be the secret of the success of Mr. Freir's relay, the superiority of which over that of other relays will be better appreciated from a study of Figs. 4 and 5. The horizontal lines are divided into equal divisions of time, and the continuous vertical lines into equal increments of magnetism. The curved lines represent the gradual rise and fall of magnetism due to the corresponding variations in strength of the exciting currents; while the dotted vertical lines indicate the relative degree of magnetic intensity at which each relay becomes active. The armature of the neutral relay in Fig. 4, for instance, is supposed to become attracted when the magnetism reaches a strength of 10, whereas the Freir relay, Fig. 5, becomes actuated at a magnetic strength of about 4. The distances between A and B, and C and D, respectively, represent the length of time each relay remains *inoperative* during a complete reversal of the current, the interval *i* of no current being the same in both cases.

It is quite certain that much advantage is to be gained, by reducing, as far as practicable, the electromagnetic inertia of the receiving apparatus on long quadruplex lines of high inductive capacity. The writer has experimented in this direction with some measure of success on the common neutral relay, by magnetically insulating its iron yoke A, and making it adjustable with regard to the cores, as shown in Fig. 6. This arrangement admits of the armature B being placed (permanently or otherwise) in close proximity to the cores, without the least tendency on its part to "stick." The number of magnetic lines that may be forced across the air spaces, and through the armature, can be regulated to suit the varying conditions of the line, by simply moving the yoke A further from the cores in fine weather when the current is strong, or by bringing it up when the weather is bad and the current weak. The self-induction of a relay constructed on this principle is comparatively low, its cores charge and discharge rapidly, and, since there is little or no remanent magnetism after the cessation of the current, the received signals come clear and distinct. The number of convolutions on such a relay should be greater than in the ordinary case, in order to exalt the magnetic effects, which, owing to the high reluctance of the magnetic circuit, are greatly diminished, especially in wet weather.

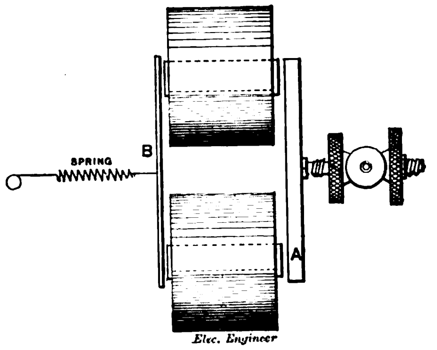


FIG. 6.—FINN NEUTRAL RELAY.

The Freir relay has, however, proved highly satisfactory under nearly all conditions of working, and is rapidly supplanting the older form of relays throughout the Western Union service.

It is not to be inferred, however, that the final stage in the development of the quadruplex system has yet been reached, and devices for remedying certain other defects, both great and small, which still exist, are continually turning up.

One of the latest and most successful of these is an invention by Mr. O. K. Newton, of the Western Union, for suppressing "sparking" at the points of the pole changer, and which, incidentally, also diminishes the interval of no current. This is accomplished by interposing a resistance of about 1,500 ohms in the circuit for a brief period immediately after *direct* contact with the battery has been broken. The extra current of self-induction, instead of darting across the air space between the points P P of the relay is diverted through this resistance, as will be seen by referring to Fig. 7.

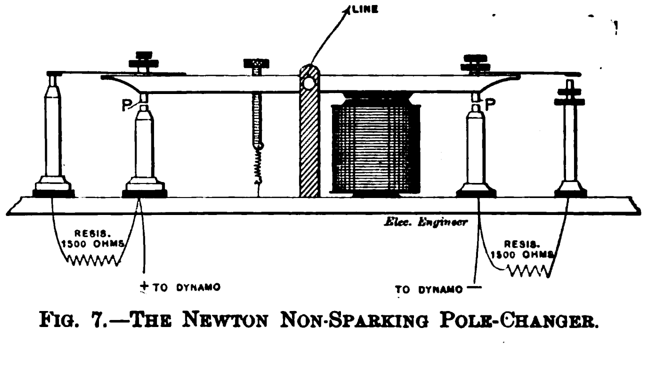


FIG. 7.—THE NEWTON NON-SPARKING POLE-CHANGER.

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EDITORIAL ANNOUNCEMENTS.

Addresses.—*Business letters should be addressed and drafts, checks and post-office orders made payable to the order of* THE ELECTRICAL ENGINEER. *Communications for the attention of the editors should be addressed,* EDITOR OF THE ELECTRICAL ENGINEER, 203 *Broadway, New York City.*

Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

VOL. XIII. NEW YORK, MAY 4, 1892. No. 209

It has been proved pre-eminently in America that the mind and hands can be trained at the same time and without prejudice to either.—Coleman Sellers.

THE ELECTRICAL ENGINEER has removed its offices to the fine new *Mail and Express* building, Broadway and Fulton Street.

The address is 203 Broadway.

MUNICIPAL LIGHTING PLANTS IN OHIO.

THERE has been a general supposition that New England was the region in which the idea of municipal electric light plants had made the most headway, but it would appear that Ohio has the craze about as badly as any other part of the Union. Not only have efforts recently been made to establish municipal plants in Cleveland and Cincinnati, but at the present time ten towns have been authorized by the Legislature to submit the question to popular vote. Berea, with 2,500 inhabitants, wants to issue $18,000 of bonds; Medina, the same; Niles, with 4,300 people, is spending $15,000 on electric lights and waterworks; Mt. Gilead, with 1,400 people, is to spend $20,000 in electric lights and roads. Napeleon, population 2,800, is to vote on $60,000 for electric lights and waterworks; Chicago Junction, 1,300 population, wishes to spend $25,000 on a village plant; Wapakoneta, with 3,600, votes on spending $20,000: West Liberty, with a bare 1,000 people, is to vote on $15,000 of bonds; Germantown, with less than 1,500, is to appropriate $10,000; and West Milton, with a mere trainload of people—850—is to raise $25,000 by bonds for a town hall and electric lights.

One can have no fault to find with the desire for, and high estimation of, the electric light thus evinced; but it remains a matter for regret that so many communities should be ready to burden themselves with heavy debt and taxation to secure doubtful returns.

LIGHTING WITH HIGH FREQUENCIES.

THE cable dispatch which appeared in our columns several weeks ago gave the first details in this country of the experiments in the lecture delivered by Mr. Tesla in London. Though necessarily brief in outline, it, nevertheless, gave sufficient indication of the fact that the lecturer had already made a decided step beyond the results brought by him before the American Institute of Electrical Engineers nearly a year ago. With the full text of Mr. Tesla's London lecture before us, as issued by the London Institution of Electrical Engineers, the opinion expressed at that time is more than confirmed, as we have a remarkable exemplification, in all directions, of the various lines of work undertaken by Mr. Tesla. He has, however, dwelt more particularly on one or two points which are pertinent at this time, in view of the fact that recent experimenters, among them Siemens, have attempted to show that the results obtained by Mr. Tesla could also be achieved at much lower frequencies than he employs. On this point Mr. Tesla placed himself on record by admitting that some of his experiments may be performed at low frequencies, but he held that very high frequencies are desirable, not only on account of the many and enhanced effects secured by their employment, but because by their means it is convenient, in turn, to obtain the necessary high potentials required for this work. He also points out that with lower frequencies the coils required are very much larger than would otherwise be necessary, so that on the score of commercial economy alone, if on no other, high frequencies are desirable.

Mr. Tesla also described a variety of apparatus for obtaining rapid disruptive discharges, in which he included the use of both an air blast and an electromagnetic blast to blow out the arc formed between the knobs. In these experiments with a peculiar discharger consisting of multiple gaps, Mr. Tesla touches very closely on the recent work of Mr. Alexander J. Wurts, and throws light on the results obtained by the latter gentleman. Thus Mr. Tesla shows that the dielectric strength of a given total width of air space is greater when a great many small air gaps are used than with a single one; and that the working with a smaller length of air gap results in a smaller loss and less deterioration of the metal of the knobs. Again, by the splitting of the arc into smaller ones, the polished surfaces last much longer. Mr. Tesla also shows that the sparking distance is much diminished as the frequency is increased.

Another important argument in favor of the employment of high frequencies is brought out by Mr. Tesla in experiments which prove to him that in the search for novel methods of producing light by an agitation of the atoms or molecules of the gas we need not limit our researches to the vacuum. He looks forward quite seriously to the possibility of obtaining the light effects without the use of any vessel whatever, with air at ordinary pressure. Thus Mr. Tesla, with his experimental coil, has been able to produce a strongly luminous sheet, covering an area of more than one square meter between wires placed in the ordinary atmosphere. Oil insulation has also, of necessity, forced itself upon the attention and claimed the study of Mr. Tesla, who advocates its use; and he believes that our future distributions of electrical energy and high tension currents will be effected by the aid of liquid insulation.

In his Columbia College lecture Mr. Tesla exhibited a variety of forms of lamps operated by means of one and two wires, as well as without wires, and his later researches have led him to a still greater variety in this respect. His latest efforts seem to be in the direction of concentrating as much energy as possible upon a refractory body of small size, and heating this together with the surrounding atmosphere to the highest possible incandescence. Of all the bodies experimented with, the "carborundum" of Mr. E. G. Acheson seemed to give the best results. With buttons of this material, the blackening of the globe is very slight, which suggests to Mr. Tesla its employment as a coating for the filaments of ordinary incandescent lamps. This material, however, does not phosphoresce, and thus follows the general law that conductors cannot phosphoresce. This leads Mr. Tesla to inquire what there is in such a body as a metal, for instance, that deprives it of the quality of phosphorescence. He reasons that it is quite possible that at some extremely high frequency, when behaving practically as a non-conductor, metal or any other conductor might exhibit the quality of phosphorescence, even though it be entirely incapable of phosphorescing under the impact of a low frequency discharge. Mr. Tesla points out in this connection that the high incandescence of the electrode is not the only result to be striven for. The more important factor is the high incandescence of the gas surrounding the button, by which means a far greater economy is obtained, and owing also to the fact that with a surrounding atmosphere the button is comparatively relieved. To obtain these effects Mr. Tesla finds it preferable at high frequency to employ only one electrode and one connecting wire. He also affirms his conviction that the illuminating device of the near future will not require for its operation more than one lead, and at any rate will have no leading-in wire, since the energy required can be transmitted through the glass.

On the question of personal safety in the operation of such appliances Mr. Tesla considers that there are two ways of rendering an electric appliance safe. One is to use low potentials, the other is to determine the dimensions of the apparatus, so that it is safe, no matter how high the potential is used. Still another reason why high frequencies are desirable is to be found in the fact that, the higher the frequency the slower would be the exchange of the air in the vicinity of the incandescent electrode, and hence the less the loss of energy. Mr. Tesla believes, indeed, that a frequency may be reached at which there would be no exchanges whatever of the molecules around the terminal. It would, in fact, be a rigid flame, and Mr. Tesla believes that contrary to what might be supposed, these effects may be obtained with comparatively low frequency. He was even able to obtain some results of this nature with frequencies as low as ten thousand per second.

To dwell upon the many points elaborated by Mr. Tesla would lead us far beyond the limits of our space, but the descriptions by Mr. Tesla, the reasons which led him to the construction of his various types of apparatus, the application of his deductions to the explanation of many electric and magnetic phenomena in nature, all furnish an instructive and fascinating continuation of a work, the first chapter of which was brought out at Columbia College last year.

THE EDISON INCANDESCENT LAMP LITIGATION.

More than twelve years after the issue of Edison's fundamental patent, and seven years almost to a day, after the commencement of legal proceedings by the Edison Electric Light Company against the United States Electric Lighting Company, the beginning of the end in the long-protracted incandescent lamp litigation has been reached. The case having been decided in the Circuit Court in favor of the Edison Company, the United States Company carried the case to the Circuit Court of Appeals, which tribunal now has final jurisdiction in all patent cases, and on Wednesday of this week, after eight days of argument by the ablest counsel of the land, the case goes to Justices Lacombe and Shipman for final decision. Summed up in brief, the contention of the complainant is, that to Edison the world is indebted for the art of incandescent electric lighting, and that the most essential instrumentality of the art, the high-resistance carbon lamp, is covered by the patent sued upon. The contention of the complainant, on the contrary, is that whatever Edison may have invented, the particular patent sued on neither describes nor covers the invention in controversy, and moreover, that the complainant, having delayed for many years to commence suit, during which time the defendant had invested large amounts of money in the business, should at least be required by the court to permit the defendant to continue the manufacture of lamps upon the payment of a reasonable royalty. We regret that the pressure upon our columns precludes the possibility of presenting more than the briefest outline of the arguments which have been presented by the able counsel on both sides.

THE TELEPHONE PATENTS.

It is now some months since the issue of the Berliner microphone patent gave rise to a great amount of newspaper discussion, of a character which, to say the least, was much more vehement than enlightening. A contributor to The Electrical Engineer, in commenting upon the matter at the time, took occasion to express a conviction that, as he aptly phrased it, the much-sought-for Ethiopian was concealed in an entirely different part of the wood-pile from that which was just then being so industriously overhauled, and to venture a prophecy that the controlling patent would ultimately turn out to be that of Edison. The expected issue on May 3, of a patent to Edison upon an application originally filed so long ago as July 20, 1877, shows that our contributor was right in his conjecture. Whether the proceedings which have kept this application pending in the Patent Office for fifteen years, have been conducted throughout in absolute good faith, is a question which, in the absence of definite information it would be premature to discuss, although there is already plenty of discussion on the subject.

ELECTRIC RAILWAY POLE LINE CONSTRUCTION.

BY

W. F. D. Crane, M. E.

Part I.—Iron Poles.

A noteworthy feature in the building of electric street railways in cities at the present time is the tendency toward construction of the most substantial and permanent character. Iron has almost universally superseded wooden poles; and the "extra strong" and more expensive pole is rapidly superseding poles of less strength and suitability. The reasons are apparent. A weak pole strained up to, or beyond its elastic limit, has no margin of strength to withstand accidents incidental to overhead construction. On the other hand a broken span wire is less expensive than a bent or broken pole.

In view of these facts and the growing demand for the heavier poles there is reason to believe that poles which shall be standards of use for streets of ordinary widths will be of "extra heavy" pipe and of the following dimension:

5 in., 4 in., 3 in. pipe 27 to 28 ft. long for streets from 30 to 40 ft. between curbs.
6 in., 5 in., 4 in. pipe 27 to 28 ft. long for streets from 40 to 60 ft. between curbs.
7 in., 6 in., 5 in. pipe 28 to 30 ft. long for ordinary pull-off poles.
8 in., 7 in., 6 in. pipe 28 to 30 ft. long for extraordinary strains.

There is a difference in the amount of tension put upon the span-wire. Some engineers prefer a comparatively weak pole with span-wire at low tension and deep sag; thus saving something in first cost but losing in sightliness of the line. Better practice, however, dictates a tightly strung span-wire with not more than nine to twelve inches sag and the use of strong, stiff poles strained within three to six inches of the elastic limit and abundantly able to meet accidental strains incidental to the carrying of guard, span and feeder wires.

Side poles are usually buried six feet in the ground and set in concrete or ballast from four to six or more inches thick around the butt. Pull-off and strain poles are usually buried from six to seven feet, depending upon the character of the soil, and reinforced by substantial concreting, ballasting or the judicious use of large stones. A suitable concrete is made from one part cement and three parts sharp sand, thoroughly mixed with stones not larger than goose-eggs. The rake away from the street, to be given iron poles will depend upon the character of the soil, width of street, weight of trolley line and fixtures, and the margin allowed for the elastic limit, and will vary from six to twelve inches according to the conditions.

Centre poles on straight streets, not being subject to severe side strains, may be advantageously made of lighter pipe, 5 in., 4 in., 3 in., and 6 in., 5 in., 4 in., standard weight, from 26 to 27 ft. long being common sizes, buried five feet or more in the ground. When the line follows the windings of streets and the poles are subject to side strains, heavier poles become necessary; a 6 in., 5 in., 4 in. extra strong pipe pole guyed at head and arms, diamond-guyed at intervals, answering most purposes. Centre poles when situated in the open street, should invariably be provided with wheel guards.

Bracket-arm poles, depending upon the length of pipe arm and weight of trolley wire, are made of extra strong pipe, 5 in., 4 in., 3 in., or of standard weight pipe, 6 in., 5 in., 4 in., 27 to 28 feet long, buried from five to six feet in the ground, as soil or setting may require. Bracket-arm poles under side strains should be made of 6 in., 5 in., 4 in., extra strong pipe, and guyed at intervals, as in the case of centre poles under similar conditions.

Poles should align truly, and have, apparently, the same rake. Cast iron bases should be provided to conceal the marring of flagstones or sidewalks which might otherwise be difficult to repair.

Before setting iron poles, the butts, for a distance of at least one foot above the ground line, should be thoroughly painted with a heavy coat of asphalt or other preservative paint. It is assumed that the poles have already received at least one coat of paint to prevent rusting while in transport or on storage. Where circumstances permit, it is highly desirable to paint iron poles with one of the better insulating paints which are manufactured for this and similar purposes. The point of greatest strain is at the ground line. This is also the point at which the paint deteriorates most rapidly, owing to alternate wet and dryness. Frequent painting here will undoubtedly add several years to the life and strength of the pole.

Poles should be painted at least once every three years, and oftener, if required. Handsomely painted poles add much to the appearance of a line.

CENTRAL STATION STATISTICS.

BY

Horatio A. Foster

I notice on page 352 of the April 6th issue of the Engineer Mr. Pope's remarks on the "Status of Lighting Companies in Massachusetts," and think I am in position to appreciate the difficulty of getting just the detail he asks for. I wish to call Mr. Pope's attention to the following list of expenses as asked for in the schedule for Electric Lighting Central Stations by the United States Census Bureau. I think it would be difficult to devise a list which would more accurately cover the points he names.

When it comes to filling it out the trouble begins, as a large proportion of the companies divide their expenses among very few accounts, many having but one account, and that "expense," to which is charged everything from coal to a dynamo brush. Again, many keep no double-entry books whatever. I have examined a large number of central stations in the past year, and think I can appreciate the position of the Massachusetts gas commission when they ask for a law to enable them to fine companies for not returning their schedules.

Expenses as asked for in Census Schedule for Central Lighting Stations.

Office Expense:
  Rent, salaries, sundries.

General Fixed Charges:
  Insurance, total annual premium.
  Interest, at — per cent., on total investment.
  Taxes, rate per cent. —, annual amount.
  Patent licenses and royalties.
  Franchise licenses and royalties.
  Depreciation on buildings.

Steam Plant, Station Expenses:
  Wages.—Engineers, firemen, helpers, etc.
  Supplies.—Fuel, oil, waste water, repairs, sundries.

Fixed Charges:
  Rent, annual amount (divide with electric plant).
  Depreciation on plant, rate per cent. —, annual amount.

Electric Plant, Station Expenses:
  Wages.—Dynamo engineers, helpers, etc.
  Supplies.—Oil, waste, repairs, sundries.

Fixed Charges:
  Rent, total annual amount (divide with steam plant).
  Depreciation on plant, rate per cent. —, annual amount.

Distribution Expenses:
  Wages.—Superintendent, inspectors, linemen, trimmers, all other employees.
  Supplies.—Incandescent lamps for renewals, carbons for arc lamps, globes for arc lamps, hoods for arc lamps, lamp repairs, poles and other supports, repairs, wire used for repairs, sundry supplies, sundry repairs, contingencies.

Fixed charges.—Rentals for poles, rentals for housetop privileges, rentals for elevated railway privileges, rentals for conduits and underground, depreciation on line construction at rate per cent.—, total annual amount.

WATER-POWER PLANT EXPENSE:
Repairs, depreciation, rate per cent.—, total amount; sundry charges for maintenance, rental if not owned.

RECAPITULATION:
Office expense.
General fixed charges.
Steam plant.
Water-power plant.
Electric plant.
Distribution.
TOTAL.

PUTTING IN EDISON HOUSE SERVICES IN BOSTON.

RECENT issues of THE ELECTRICAL ENGINEER have contained descriptions of the methods of putting in Edison house services in New York and Boston, and below we give the details of the work as done in the Boston Edison stations, and for which we are indebted to Mr. C. L. Edgar, general superintendent of the company.

Three forms are employed in order to keep a thorough check on the work.

[1]

EDISON ELECTRIC ILLUMINATING CO.
OF BOSTON.

BOSTON, MASS......................189
Order No. 664 A

To Mr...
Foreman.
Connect No.......................... ....Street.
Occupied by ....
To the...Service.
Size of Service } Main, } ....
Remarks } Repairs } ....
....
..........Acct. ....Dist.
WM. H. ATKINS, Supt.
Completed..189
....Foreman.

[2]

Underground Department.

To Mr...
Account.......... ... Job No..............
Connect } Repair } ....

STOCK USED.

....
....

TIME.

Name.	Hrs.	Name.	Hrs.
....	....	....	....
....	....	....	....

Size of...
Trouble found....................................
....
Completed........ .... 189.., ...
Sub-Foreman.

[3]

COST SLIP.

Service } Repair } ....
Size.............Length.............Holes...............
Stock...
....
....
Time..
....
....
....Foreman.
Cause of trouble..........

The first form, No. 1, is given to the foreman to connect the service at the given place, and states the size of the service and the account to which it is to be charged. This slip is numbered, as will be noted, and is accompanied by a duplicate. The original slip is given to the foreman and the duplicate is entered upon a slip-book in the office. This number follows the job throughout of all stock used and of labor spent upon the same. After the foreman receives this slip he, in turn, issues slip No. 2 to the jointer, who is to put in the service. This is for the use of the jointer in keeping the amount of stock used and time consumed on the job, and at the same time, if he is working on repair work, to make remarks on the trouble found, etc.

After the job is completed the foreman turns back the original slip, Form 1, together with a cost slip, Form 3, which shows the total amount of stock used and the time consumed on the job and the size and length of the service. This is compared with the amount of stock which is charged on the books against that number, and, if it checks, is entered up on the stock statement and charged against the proper account.

DYNAMO-ELECTRIC MACHINERY.—I.[1]

BY J. HOPKINSON, F. R. S., AND E. WILSON.[2]

THE following is intended as completion of a paper by Drs. J. and E. Hopkinson (*Phil Trans.*, 1886, p. 331). The motive is to verify by experiment theoretical results concerning the effect of the currents in the armature of dynamo machines on the amount and distribution of the magnetic field which were given in that paper, but which were left without verification. For the sake of completeness, part of the work is given over again.

The two dynamos experimented upon were constructed by Messrs. Siemens Brothers & Co., and are identical, as far as it is possible to make them. They are mounted upon a common baseplate, their axles being coupled together, and are referred to in this paper respectively as No. 1 and No. 2.

Each dynamo has a single magnetic circuit consisting of two vertical limbs extended at their lower extremities to form the pole-pieces, and having their upper extremities connected by a yoke of rectangular section. Each limb, together with its pole-piece, is formed of a single forging of wrought iron. These forgings, as also that of the yoke, are built up of hammered scrap iron, and afterwards carefully annealed. Gun-metal castings bolted to the base-plate of the machine support the magnets.

The magnetizing coils on each limb consist of 16 layers of copper wire 2 mm. diameter, making a total of 3,968 convolutions for each machine. The pole-pieces are bored out to receive the armature, leaving a gap above and below subtending an angle of 68 degrees at the centre of the shaft. The opposing surfaces of the gap are 1.4 cm. deep.

The following table gives the leading dimensions of the machine:

	cm.
Length of magnet limb	66.04
Width of magnet limb	11.43
Breadth of magnet limb	38.10
Length of yoke	38.10
Width of yoke	12.06
Depth of yoke	11.43
Distance between centres of limbs	23.50
Bore of fields	21.21
Depth of pole-piece	20.32
Thickness of gun-metal base	10.80
Width of gap	12.06

---

[1] Abstract of paper read before the Royal Society.

[2] It must not be supposed from his name not appearing in this short paper that my brother, Dr. E. Hopkinson, had a minor part in the earlier paper. He not only did the most laborious part of the experimental work, but contributed his proper share to whatever there may be of merit in the theoretical part of the paper.—J. H.

The armature core is built up of soft-iron discs, No. 24 B. W. G., which are held between two end plates screwed on the shaft.

The following table gives the leading dimensions of the armature:

	cm.
Diameter of core	18.41
Diameter of shaft	4.76
Length of core	38.10

The core is wound longitudinally according to the von Hefner-Alteneck principle with 208 bars made of copper strip, each 9 mm. deep by 18 mm. thick. The commutator is formed of 52 hard-drawn copper segments insulated with mica, and the connections to the armature so made that the plane of commutation in the commutator is vertical when no current is passing through the armature.

Each dynamo is intended for a normal output of 80 amperes, 140 volts, at 880 revolutions per minute. The resistance of the armature measured between opposite bars of the commutator is 0.042 ohm, and of each magnet coil 13.3 ohms.

In the machine, the armature core has a greater cross-section than the magnet cores, and consequently the magnetizing force used therein may be neglected. The yoke has the same section as the magnet cores, and is therefore included therein, as is also the pole-piece. The formula connecting the line integral of the magnetizing force and the induction takes the short form $4\pi n c = 2l_2\, I/A_2 + l_3 f(\nu I/A_3)$,[3] where

n is the number of turns round magnet.

c is the current round magnet in absolute measure.

l_2 the distance from iron of armature to rim of magnet.

A_2 the corrected area of field.

I the total induction through armature.

l_3 the mean length of lines of magnetic force in magnets.

A_3 the area of section of magnets.

ν the ratio of induction in magnets to induction in armature.

f the function which the magnetizing force is of the induction in the case of the machine actually taken from Dr. J. Hopkinson on the "Magnetization of Iron," *Phil. Trans.*, 1885, Figs. 4 and 5, Plate 47.

In estimating A_2 we take the mean of the diameter of the core and of the bore of the magnets, 19.8 cm., and the angle subtended by the pole-face, 112 degrees, and we add a fringe all round the area of the pole-face equal in width to the distance of the core from the pole-face. This is a wider fringe than was used in the earlier experiments (*Phil. Trans.*, p. 337), because the form of the magnets differs slightly. The area so estimated is 906 sq. cm.

l_3 is taken to be 108.8 cm.

A_3 is 435.5 sq. cm.

ν was determined by the ballistic galvanometer to be 1.47. It is to be expected that, as the core is actually greater in area than the magnets, ν will be more nearly constant than in the earlier experiments. It was found to be constant within the limits of errors of observation.

Referring to Fig. 1, the curve C is the curve $x = l_3 f(\nu\, y/A_3,)$ and the straight line B is the curve $x = 2\, l_2\, y/A_2$, whilst the full line D is the characteristic curve of the machine $x = 2\, l_2 y/A_2 + l_3 f(\nu\, y/A_3,)$ as given by calculation.

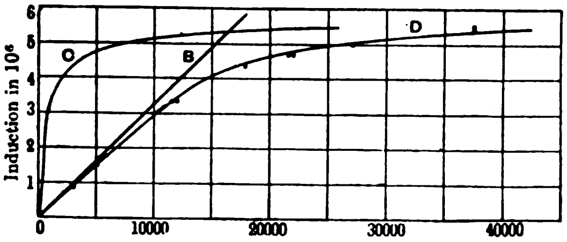

FIG. 1.

The marks + indicate the results of actual observations on machine No. 1, and the marks 0 the results on machine No. 2, the total induction I being given by the equation:

$$I = \frac{\text{Potential difference in volts} \times 10^8}{208 \times \text{revolutions per second}}.$$

Experiments made upon the power taken to drive the machine under different conditions show that it takes about 250 watts more power to turn the armature at 660 revolutions when the magnets are normally excited than when they are not excited at all. The volume of the core is 9,465 cub. cm., or in each complete cycle the loss per cub. cm. is

$$\frac{250 \times 10^7}{11 \times 9{,}465} = 24{,}000 \text{ ergs.}$$

The loss by hysteresis is about 13,000 (*Phil. Trans.*, 1885, p. 463) if the reversals are made by variation of intensity of the magnetizing force, and the iron is good wrought-iron. This result is similar to that in the earlier paper (p. 352), where it is shown that the actual loss in the core, when magnetized, is greater than can be accounted for by the known value of hysteresis.

THE FISHER AUTOMATIC CUT-OUTS.

BY

HENRY W. FISHER.

THESE cut-outs are designed so as to open the main circuit or any other circuit when the E. M. F. of the working circuit becomes greater than that for which the cut-out has been set. The principle on which they operate is believed by the writer to be entirely new and is exemplified in the accompanying engravings, Figs. 1 and 2, which represent a cut-out designed for arc circuits. The former shows the position of the various parts before operation and the latter after operation.

It will be noticed that the essential feature of the cut-out is a fine, strong thread that passes between two sets of needle points, holding by suitable fixtures the arms of the switch in place. As soon as this thread is burned by the passage of a spark across the points, the circuit is instantly opened, as shown in Fig. 2, and as will be more fully explained later on. The writer will first describe the arc light cut-out, then he will mention some rather severe tests to which it was subjected and the various uses which it subserves.

The cut-out, as shown in Fig. 2, is about 20 inches long and 8 inches wide; it can be adjusted so as to open the circuit at any voltage ranging from 1,000 to 6,000 volts; its action is extremely rapid, and it responds instantly to an increase of E. M. F., which may happen to reach or become greater than the voltage for which it is set. The central part is a piece of hard rubber upon which certain brass pieces are mounted; this hard rubber base is removed by taking hold of the handle *j* and pulling in an upward and outward direction. The writer can best describe it by telling how to reset the various parts.

After the circuit has been opened, as shown in Fig. 2, the hard-rubber piece is removed and then one end of the thread is knotted and placed in the groove *f*; then the thread is extended around the pins in *m* and *m'*, back from the point in *e* around *f*, whereupon the string is brought into tension by turning the spool, at the same time loosening or relieving *m* and *m'* until they and *e e* assume the position shown in Fig. 1. The old needles are now removed from the grooves in *k k* and *l*, replacing them by new ones; the needles in *l* are fixed so that the points are just above and touching the thread; the gauge is placed between each set of points in turn and the needles in *k* are advanced until the points are just the thickness of a gauge apart. Mention will be made of this gauge later on.

The parts *h h* are resistances, which are designed so as to stand the strain of being suddenly subjected to high voltages and yet which permit sufficient current to pass to burn the thread instantly. When the hard-rubber part is set up for the first time, or when the cut-out is going to be used for a different voltage, the resistances *h h* are inserted for the voltage in question between the holders *i* and *i'*. The resistances as sent out on the market are stamped for the voltage for which they are to be used, but they will stand under the action of the cut-out two or three times the pressure for which they are designed.

The rubber base is now ready to be put in place, and to do this the brass catch *d* is placed in a groove in the marble and the rubber base is brought into its final position by pressing with a downward and inward pressure; by so doing *p* is connected electrically with *m*, *q* with *o*, *p'* with *m'* and *l* to a ground wire terminal at the back of the marble base. The base is fastened to the wall in a vertical position by four long screws, and is held from the wall by four suitable pillars or insulators; after the hard rubber part is in place, the arms *c c* are latched with *e e*; then the rubber handles *x x* are grasped and the notched connectors *z z* are forced into place. Before closing these, however, it is advisable to regulate the pressure of the brushes *v v* by their screws, so that the collar *t t* will just be forced all the way to *r r* by the springs *s s*.

The main wires from the dynamo are connected to *r r* by suitable binding posts, and the wires running to the outside circuit are taken off from *a a*. The arms *c c* are made of spring brass so as to allow the end of the connectors to be shoved into place in order to hold them and to make good electrical contact. They are made light, and, being under considerable strain, they move very rapidly, thus liberating the connecting rods *w w* instantly. The springs *s s* are very strong, and, by the method by which they are made to move the arms *w w*, great rapidity of break is insured; moreover, the springs *g g* are designed so as to impart rapid motion to the parts *e e*; these also serve as a means of making electrical connection from *e* to *i*; it will be noticed that the instant the cut-out operates, the electrical connection is broken between the lugs *a a* and *e e* by means of the arms *c c*; this prevents the resistances *h h* from being injured in case there happens to be a cross on the outside circuit such as might otherwise cause a current of electricity to flow from *a* to *a* through these resistances. In this particular cut-out both sides of the circuit are broken through a distance of ten inches. The marble slabs 2 2 extend over an inch above the highest of the other parts and thus effectually prevent the rubber or any of its parts from being injured by any arc that might occur at *b b*.

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[3] *Phil. Trans.* p. 335.

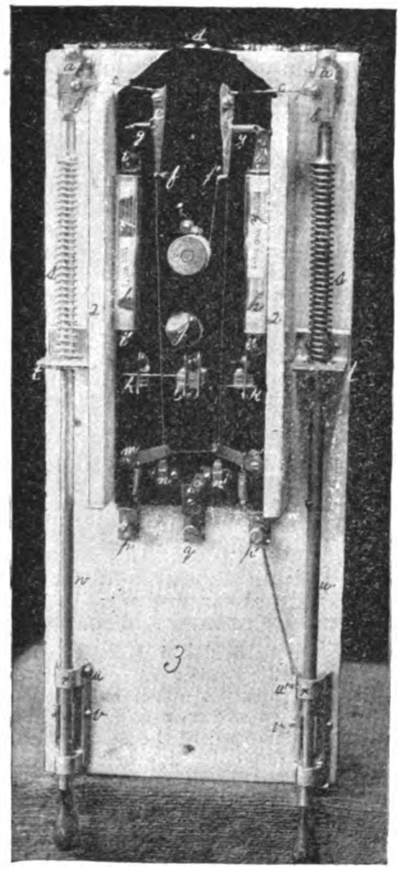


FIG. 1.—FISHER AUTOMATIC CUT-OUT.

The writer will now explain the function of the lower parts of the hard-rubber strip and the corresponding parts *p*, *q* and *p'* in the marble. A third wire is run from the brush of the field side of the dynamo to *q*. The connector *o* is constructed so that electrical connection can be made between *q* and *n'* or between *q* and *n*, as desired; *p* or *p'* can also be connected to *u* or *u'* by a suitable wire. The object of the switches *m* or *m'* is to short-circuit the field coils of the dynamo at the instant the thread burns and this is effected by connecting the field side of the circuit with *p* or *p'*, as the case may be, placing the connector *o* at the corresponding side of the circuit. This is shown in Fig. 1, where *p'* is connected with *u'*, *u'* being a part of the brush side of the circuit; practically, the main circuit is opened simultaneously with the closing of the switches *m* and *m'*; but from several tests made the switch *m'* acts rapidly enough to cause a sudden drop of E. M. F. of the dynamo so that there is no apparent arc of breaking, and the sudden resultant rise of E. M. F., so destructive to the insulation of cable circuits, is avoided.

The object of having duplicate parts *p*, *p*, *m*, *m*, as shown in the figures, is to facilitate the linemen in making the necessary connections in case the cut-out is to be placed in a station where the wiring has already been done. If desired, an annunciator can be operated by the closing of the switch *m* or *m'*, which is not used for cutting out the field coils, thus notifying the engineer in charge that the circuit has been opened. In connection with this cut-out a suitable apparatus for measuring the double-spark length has been designed; this apparatus, by means of a micrometer device, enables one to determine the length of the air gaps for the normal E. M. F. of any given machine; having determined this to one one-thousandth of an inch, a suitable gauge of copper is constructed; this gauge, however, must be made slightly thicker than the actual sparking distance for the voltage in question. The increase in the thickness of the gauge above the actual sparking distance, depends upon the voltage and upon the type of machine. The object of doing this, of course, is to have the needle points set at such a distance that the normal working of the dynamo will not be interfered with by the opening of the circuit by the cut-out. In stations where it may be difficult to reset the parts on the hard-rubber instantly, it is desirable to use a duplicate part which can be instantly put into place, the other being reset at the leisure of the engineer in charge.

A number of tests were made with this cut-out in order to test its thorough reliability under all conditions, the alternating current being used for convenience.

Test No. 1. The needle points were adjusted so that the cut-out would not operate under a pressure of 1,000 volts, but would do so the instant the voltage was increased to 1,500 volts. The wires were run from the part *a a* of the cut-out to ten 100-volt lamps in series, which, of course, were just brought up to candle power by the 1,000-volt circuit; instantly the voltage was increased to 1,500 volts, whereupon the cut-out opened the circuit so rapidly that the lamps had not time to become any brighter.

Test No. 2. The needle points were set as before, the same ten lamps were placed in series, but a pressure of 2,000 volts was used; and upon closing the circuit switch the cut-out operated so rapidly that the filaments of the incandescent lamps had not time to reach their normal candle power, whereas, if this voltage had been placed on the lamp circuit for even a very short length of time one or more of the lamps would certainly have burned out.

The writer neglected to mention before the function of the part 1; it was stated that when the rubber piece is put in place, 1 is connected to a ground wire terminal at the back of the marble base; the object of this is twofold. In the first place, it enables the cut-out to be usd as a lightning arrester for the lightning discharge will choose the point of least resistance, namely, through the small air gaps at the needle points to ground, and this it can do from either side of the circuit, thus opening both sides of the circuit and saving the dynamo from being burned out by the lightning discharge. The second function of the ground wire connected to 1 is to enable the cut-out to open the circuit whenever a ground appears, or even when the insulation of a circuit becomes dangerously low; this is evident when we consider that by grounding one side of a circuit the air-gap has been reduced to one-half, and hence, unless there are more grounds than one in the circuit, and unless the insulation is proportionately low all over the circuit, there will be a spark across the points and the circuit will be opened.

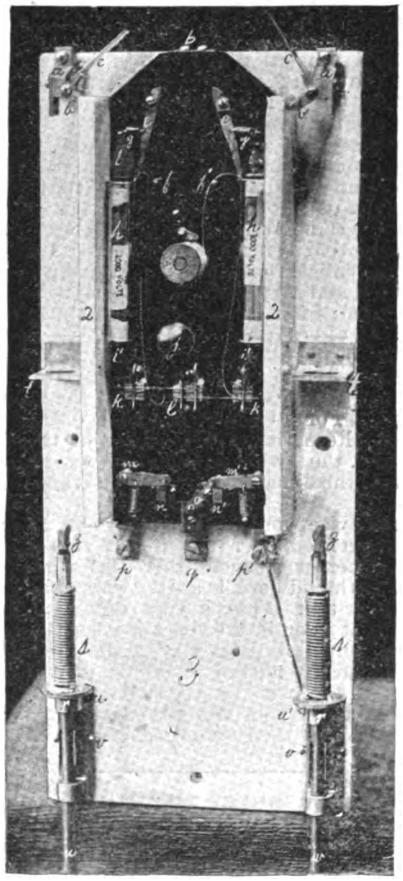


FIG. 2.—FISHER AUTOMATIC CUT-OUT.

Test No. 3. This was made to illustrate the working of the cut-out when one side of the circuit became grounded. The needle points were set so that 1,000 volts would not operate the cut-out; a pressure of 1,000 volts was used. One side of the circuit was grounded, whereupon the circuit was opened instantly.

Test No. 4. This was the most exacting test to which the cut-out was subjected and it forcibly illustrates the exceeding rapidity with which the device operates. Pieces of a cable having very thin insulation were tested with a view to determining what voltage would break through this insulation; 2,000 volts were found to do this, and so far as could be determined by the senses, the cable broke down the instant the 2,000-volt switch was closed; then a piece of this cable was connected to the circuit side of the cut-out, the points were adjusted so that the cut-out would operate under 2,000 volts and then a pressure of 2,000 volts was connected to the other terminals of the cut-out; upon closing the circuit switch the cut-out opened the circuit so rapidly that the cable was not in any way injured, as was shown by a subsequent insulation test. The same pressure was then connected directly to this same piece of cable, whereupon it broke down instantly. Subsequent tests demonstrated the efficiency of the cut-out as a protective device against burn-outs which might be caused in absence of the cut-out by the abnormal rising of the E. M. F.

The cut-out was also tested at the arc station of the Allegheny County Light Company, and a practical test was witnessed by the officials of that company, who expressed themselves as being well pleased with the result. The needle points were first set so that the cut-out would operate before the E. M. F. of the arc machine reached its normal value, namely, 2,800 volts. The cut-out operated so easily that no one present became aware of the fact for several seconds after its operation; then the points were set so that the cut-out would not operate under the normal working of the machine; after the lamps were up to full candle power one side of the circuit was grounded, the result being that the cut-out opened the circuit and the action of the short-circuit switch was so rapid that there was no visible arc whatever at the time of breaking, whereas, usually the arc is several inches long. This shows that this form of cut-out can be used on high voltage arc circuits operating through a system of underground cables, and that there need be no fear of the cables being injured by the sudden opening of a circuit by means of the cut-out.

Briefly summing up the uses of the cut-out, it may be considered as being a protection to dynamos and cables against abnormal rises in the E. M. F. of a dynamo, against crosses that may tend to augment the E. M. F. of a dynamo, against lightning discharges and against grounds. If the circuit becomes grounded and it is still necessary to operate the machine, the remedy is to disconnect the ground wire from the marble base; but this is, of course, only recommended as a temporary alternative.

The other styles of cut-outs embody the principles of the one just described, the same style of connectors and the vertical accelerated drop motion being used. The parts as shown in the lower part of the rubber base in the accompanying figures, are, however, different and they are made to suit the style of machine under consideration; for instance, if the cut-out is designed to be operated upon an alternating circuit and if it was desirable to lower the E. M. F. of the alternator before, or at the same time the circuit was opened by the cut-out, the parts *m* and *m'* would be designed so as to open the exciter circuit of the alternator at the instant of break. For a dynamo machine operating under the principle of the alternating arc machine of the Westinghouse Electric Company, the switches *m* and *m'* would be designed so as to short-circuit the dynamo slightly in advance of opening up the main circuit.

This form of device would seem to have an advantage, so far as rapidity is concerned, over the cut-outs that use the principle of the electromagnet or solenoid, there being no retardation in the circuit. The thread used is a silk twist which is very strong and yet so slender that it burns very quickly. It is stretched very tightly so that even if the spark is a small one, long before the thread is consumed it gives way under the tension and this sudden releasing has a tendency to augment the movement of the parts that are held in place by the string. This device was designed in the laboratory of the Standard Underground Cable Company, and made in their own machine shop.

THE MAGNETIC CLUB DINNER TO THE HON. JAMES D. REID.

A MOST successful dinner was given on Saturday, April 30, at the Columbia, West Fourteenth street, by the Magnetic Club to the Hon. James D. Reid, U. S. Consul at Dunfermline, Scotland, who is now on a visit to this country to celebrate his golden wedding. More than 150 members and friends sat down to dinner, under the chairmanship of Mr. W. H. Baker, in the unfortunate absence of President Cockey, who was detained at home by illness. After dinner, Mr. Baker gracefully called on Mr. W. J. Dealy to preside, and then began a flow of oratory, song and mirth that lasted pretty well all through the "red message" hours. Mr. Dealy was himself never more eloquent. Mr. Reid was received with many rounds of applause and repaid them in some very tender and charming words of thanks, the pathos and humor of which showed that he had not been spending his time in the land of Robbie Burns for nothing. The most interesting part of his address was that in which he referred to recent efforts to belittle the fame and memory of Prof. Morse, and called upon his hearers to do all in their power, should occasion arise, to defend the pure reputation of the man who had founded the great telegraphic industry with which they were all connected. Mr. Reid's eloquent appeal in behalf of his old chief and friend was heard with the closest attention and was greeted with warm approval. The other speakers were Messrs. T. F. Clark, C. A. Tinker, W. C. Humstone and R. J. Hutchinson.

BOSTON SOCIETY OF OPERATIVE ELECTRICIANS.

THE BOSTON SOCIETY OF OPERATIVE ELECTRICIANS held its regular semi-monthly meeting at the American House, last Wednesday evening, President A. T. Chase, presiding. The speaker of the evening was Mr. A. T. MacCoy, electrician of the United Telegram Co., who presented an elaborate and carefully prepared paper on the system of that company for the distribution of stock quotations. The various instruments used and the arrangement of apparatus and circuits were carefully explained, being illustrated by some of the actual apparatus and by numerous diagrams. Mr. MacCoy's paper presented in a striking manner the completeness with which the details of this system have been elaborated, and formed a worthy addition to the numerous interesting and instructive papers with which the society has been favored during the past season.

The society aims especially to bring before its members by lectures and discussions the practical applications of electrical science to regular commercial work; and persons interested in the work of the society or who might desire to become members are welcome to attend any of the meetings, which are held the first and third Wednesdays of each month at 8 P. M., at the American House, Boston.

TROPICAL AMERICAN TELEPHONE CO. DISSOLUTION.

UPON the application of Charles M. Hough, complainant, Hon. Alex. T. McGill, chancellor, issued an order, at Newark, N. J., April 20, directing the Tropical American Telephone Co. to show cause why an injuction should not issue and a receiver be appointed to close up its business; at the same time ordering that corporation to refrain from collecting or paying any money and from selling or transferring any of its property. The valid assets of the company are understood to be insufficient to meet its liabilities. It is not true as reported in other journals that the Western Electric Company has purchased a majority or any of the stock of the Tropical American Telephone Co.

AN IMPORTANT LIGHT AND POWER ENTERPRISE AT CONCORD, N. H.

THE CONCORD LAND AND WATER CO., of Concord, N. H., Geo. F. Page, president, is beginning to carry out a very important light and power enterprise.

The facts, briefly stated, are that a dam is to be constructed at Sewall's Falls during the coming season, work to be commenced upon it in May; the dam to be completed by the middle of November; the increased capital for the work being already pledged. A canvass of the city of Concord has been made for lighting and is being made for power. More than 124 arc and more than 5,000 incandescent lights, besides isolated plants, are already assured in the city of Concord. New industries are being invited, and it is expected that some will be constructed and begin manufacturing at an early day on the ground at Sewall's Falls, which is four miles above the State House or central wards of the city. Sewall's Falls are in the Merrimack River. There is a head and fall of 22 feet. A reservoir will extend 13 miles up stream when the dam is built and the flash boards are in place; 5,000 h. p. can be secured the year round by the electric installation which it is proposed to make, for it is intended to develop all the power through dynamos and distribute this power on the ground and elsewhere electrically. A beautiful site for the erection of buildings, both for residences and manufacturing purposes, is afforded by the land contiguous to the Falls. Two railways in competition pass through the property, and an electric railway passes along at one side thereof. The company will offer to parties who desire cheap land and cheap power excellent facilities for manufacturing. The rates of transportation are low. Exemption from taxation for a term of years can be secured, and everything is offered that can be asked for to make this a thriving settlement. The proposed town site will form a ward of the city of Concord, which is the capital of the State. The very best of electrical apparatus will be employed. The company are under no obligations to any one company, as they will pay cash for what they purchase, and all the work will be done under the most thorough system of engineering possible. It is intended to make this a model electrical plant in every particular, and finer than any other in the country at the present time.

Legal Notes.

THE EDISON INCANDESCENT LAMP PATENT—FINAL HEARING BEFORE THE U. S. CIRCUIT COURT OF APPEALS.

THE suit of the Edison Electric Light Company against the United States Lighting Company, for an alleged infringement of Edison's patent for an incandescent lamp, No. 223,898, which has been pending in the United States courts since May, 1885, came up on appeal for final hearing and determination on April 25, before Justices Lacombe and Shipman, in the United States Circuit Court of Appeals for the second circuit. The present hearing is an appeal from the decree of Judge Wallace, in the Circuit Court, filed July 14, 1891, by which the Edison patent was sustained and the defendant's lamps held to be infringements. An imposing array of eminent counsel were present. The Edison Company were represented by S. B. Eaton, G. P. Lowrey, C. A. Seward, A. H. Walker and R. N. Dyer. The United States Company were represented by S. A. Duncan, L. E. Curtis, E. Wetmore, and F. H. Betts.

Mr. Wetmore, in behalf of the United States Co., after rehearsing the history of the litigation in the lower court, proceeded to a consideration of one of the defenses in the case. Before proceeding to discuss the patent itself, and the issues of novelty and infringement, he would speak of a defense which was established by an admission of fact. It was that there was no complainant in this case. The corporate existence of the plaintiff, "The Edison Electric Light Company," had ceased on December 31, 1886, when that company had been consolidated with the "Edison Company for Isolated Lighting" to form a new company known as "Edison Electric Light Company." Notwithstanding the provisions of the State law, he contended that the act of consolidation conveyed no legal title in the patent in suit to the new company. Such title could only pass by a written assignment as required by the Federal statute, consequently the new company was incompetent to prosecute suit for an injunction, either in its own name or under the name of the old company, nor could the original plaintiff company longer ask for an injuuction. Its corporate functions had expired with the consolidation, it had ceased to manufacture under the patent or to exercise control over it and could no longer be injured by any infringement. The only regular procedure would have been to have transferred the legal title of the patent to the consolidated company, and then for that company under proper proceedings to have secured substitution. This not having been done, there was no party before the court entitled to an injunction. The State law provided that suits pending at the time of consolidation might be continued in the name of the old company, by order of the court in which the proceedings were pending, but a patent monopoly was surely a question of statute, and could in no wise be affected by any State legislation. The suit must be brought by the owner of the legal title. This had been established by a long series of Federal decisions. It was a matter wholly beyond the jurisdiction of the State Legislature.

General Duncan, in opening the main portion of the case for the United States Company, contended that the granting of an injunction was a substantial error of the court below. Even upon its interpretation of the patent, it ought not, in view of the equities of the case, have enjoined the defendant—certainly not upon an interlocutory decree, provided it was willing to enter into bonds to pay the plaintiff a reasonable compensation for the continued use of the invention, in case the patent had been ultimately sustained with the broad construction adopted by the circuit court. The defendant had entered upon the business of incandescent lighting, involving the use of the alleged infringing lamp early in 1880, a date practically contemporaneous with the issue of the patent in suit. It had prosecuted the business diligently and at the date of the commencement of the suit it had installed over 1,000 lighting plants having a capacity of 350,000 lamps representing a cash investment on the part of the purchasers of $5,000,000, and had itself invested capital approximating $2,000,000. The infringement complained of had beeen carried on openly in all parts of the country for five years before the commencement of the suit. Important contracts had been obtained by defendant in competition with the plaintiff. Finding abundant reason in plaintiff's conduct to suppose that no attack would be made, defendant had gradually enlarged its operations from year to year, and had been led to invest a vast amount of money in the business of manufacturing, all of which capital would be imperiled if an injunction were to be granted. Moreover, the plaintiff by its contracts with Mr. Edison, had parted with its right to manufacture lamps and by its contract with local companies had parted with the right in the large part of the territory of the country to use and sell lamps embodying the Edison invention. It did not appear that the plaintiff, who was not a manufacturer of lamps, would suffer more than a merely nominal injury for the refusal of the injunction, while the granting of the injunction would imperil millions of capital, not merely capital invested by the defendant, but the capital of local lighting companies in all parts of the country. Under all the circumstances, sound practice would seem to have dictated, that the question of injunction should have been reserved until the coming in of the master's report, and the settlement of the final decree. Either therefore the decree below should be reversed absolutely as to the injunction clause, or the injunction should be modified, and made conditional upon defendant's refusal to file the bond with proper security to pay plaintiff such royalty for the lamps which it might hereafter make, use or sell, as the court should ultimately adjudge be reasonable and just.

Two excuses had been offered for the delay in commencing this suit. Major Eaton, who was then president of the company, has testified that they were perfectly aware of the competition of the defendant, but did not think it amounted to much and did not care to spend time or money in prosecuting the matter. They proposed to wait until the business of the defendant had become of serious importance. They say furthermore that they preserved their legal rights by giving notice to the defendant, which was all they were required to do. Defendant would contend that the reasons which had been assigned for that delay were not substantiated by the record. The infringement had been of a serious character. Two years after the date of the patent the Edison Company had sold 34,000 lamps; three months after that the defendant had sold 36,000 lamps. The notices alleged to have been sent out contained simply a list of 160 patents, and a statement to the world at large that if any one of those patents should be infringed, the company was going for them. Defendant had received a copy of the notice and so had all other electric lighting companies. Such a notice could not establish a right to wait indefinitely before suing for an infringement that had been going on on a large scale for years. Their other excuse had been that the state of the law by repeated decisions in the Circuit Court had led them to believe that the patent now in suit had expired by reason of a prior short-term Canadian patent; that they had a right to rely upon that as the settled law, and that it so continued until the Supreme Court in January, 1889, had reversed the decision of the circuit, and hence that from that time only they had been chargeable with diligence in the prosecution of infringers. But they could not complain if defendants also, relying not only on plaintiff's delay in bringing suit, but upon repeated adjudications in circuit, had invested millions of dollars in the business of building up electric light manufactures; and having done that during the pendency of plaintiff's delay, it did not lie in their mouths now to say that they had a right under the law, as it had been expounded though erroneously by the lower court, to delay bringing suit during all that time.

Upon the admitted facts as presented, what was the part of equity? If it were true that during this period of delay, defendant had maintained active competition with plaintiff, and had received no notice from plaintiff alleging infringement upon the rights covered by this patent, were they to be enjoined? If for every lamp sold there had been put out apparatus twenty times the value of the lamp, was an injunction to go that would destroy those investments? Was there any corresponding benefit to the plaintiff which would justify such a harsh application of the doctrine of injunction? He would contend also, that in view of the extraordinary laches in this case, it was incumbent upon the plaintiff to show affirmatively that no injury would come to the public. What was going to become of the $80 invested in electric plants for every dollar invested in lamps? General Duncan then cited a great number of cases in which the court had refused an injunction, on the ground that the owners of the patent had been dilatory in asserting their rights, and contended that even if it were true that there had been no adjudicated cases in which laches had continued for a period less than five years, and in which the court had refused an injunction, that was no reason why this court should not make a precedent. The question was, What was equity? Judge Story, in *Wyeth vs. Stone*, after citing a long list of authorities, had thrown them all aside and had said: "But if there were no authority on this point, I should not have the slightest difficulty in asserting the doctrine, as founded in the very nature and character of the jurisdiction exercised by courts of equity on this and other analogous subjects." To say that the plaintiff had not lost his rights because he had not waited six years, when, in fact, he waited five years, and until defendant had invested millions of dollars, believing that he had a right to make this right seemed almost puerile.

General Duncan then entered upon elaborate explanation of the construction and the principles involved in the operation of the incandescent lamp, which lack of space reluctantly compels us to omit. In the course of this, he pointed out the importance of high resistance in the lamp, and called attention to three elements of resistance which he said were important to be kept in mind, viz., specific resistance, cross-section and length, all of which were determining factors in the total resistance. In electric lighting by incandescence there was one prime rule to be observed, which was not only embodied in all modern commercial lamps, but from defendant's point of view had been embodied in every lamp ever made. It referred to the smallness of the cross-section of the burner. If it were asked what is meant by "smallness of cross-section," it was difficult to answer. The other side had contended that it was the very essence of the invention covered by the patent, but neither in all the discussion in the court below nor in the voluminous brief filed in the present case had defendants answered that question. General Duncan then explained that it was desirable, in order to keep down the volume of light, to have a small burner rather than a large one. Another reason for having a small cross-section was to get the necessary resistance for economical work. A third reason was that with the limited supply of current a small burner might be brought to incandescence when it would be impossible to do so with a large one. The remainder of the day was occupied by General Duncan in explaining the difference in the results obtained by arranging the lamps in series or in multiple arc.

TAXING THE WESTINGHOUSE CO. NOT LEGAL.

In the case of the Westinghouse Electric Company the Supreme Court of Pennsylvania has held that it is a manufacturing corporation, and therefore not liable to tax on its capital stock, which is largely invested in patent rights covering important improvements in electrical appliances. The court is careful to point out that while the intangible right existing in a patent may not be taxed, the tangible articles manufactured under patent rights are legitimate subjects of taxation.

Society and Club Notes.

PRELIMINARY ARRANGEMENTS FOR THE WORLD'S ELECTRICAL CONGRESS.

Dr. Elisha Gray, chairman of the Committee on Electrical Congress, of the World's Columbian Exposition, has sailed for Europe, where he will spend three or four months devoted chiefly to a study of questions connected with the Congress. Prof. H. S. Carhart, of Ann Arbor, secretary of the committee, will also spend some time abroad. Active work in this country will be resumed in the fall. Before leaving New York for London, Dr. Gray called a meeting of the Eastern members of his advisory council, on April 26, at the headquarters of the American Institute of Electrical Engineers, when a large number participated in an active discussion of various details connected with the organization of the Congress, its work, time of holding it, qualifications of membership, etc. One point that was practically settled is that, if possible, the Congress shall be held the last week in August of 1893.

The following gentlemen have been appointed to constitute the Advisory Council of the World's Congress of Electricians:

England.—Sir William Thomson, F. R. S. (Lord Kelvin), The University, Glasgow; William H. Preece, F. R. S., Electrician-in-Chief, General Post-Office, London; Prof. W. E. Ayrton, F. R. S., City and Guilds of London Institute, Central Institution, Exhibition Road, London; Lord Rayleigh, Terling Place, Witham, Essex; Prof. S. P. Thompson, D. Sc., London.

France.—Prof. E. Mascart, College de France, No. 176 Rue de l'Université, Paris; E. Hospitalier, No. 6 Rue de Clichy, Paris.

Germany.—Dr. Werner Siemens, Berlin; Prof. H. Von Helmholtz, Berlin.

Italy.—Prof. Gallileo Ferraris, Turin.

Austria.—Joseph Kareis, K. K. Baurath, Wien II., am Tabor 6.

Switzerland.—Prof. Dr. Weber, Ecole Polytechnique, Zurich.

Belgium.—Prof. E. Gerard, Inst. Electro-Tech. de Montefiore, Liege.

Russia.—Prof. A. Repman, Moscow; Prof. A. Stoletow, Moscow.

Mexico.—S. Yslas, de los Telegrafos Federales, City of Mexico.

Spain.—Director General of Telegraphs, Madrid.

U. S. A.—Prof. Geo. F. Barker, M. D., University of Pennsylvania, Phila., Pa.; Prof. C. F. Brackett, College of New Jersey, Princeton, N. J.; Prof. Henry A. Rowland, Ph. D., Johns Hopkins University, Baltimore, Md.; Prof. T. C. Mendenhall, LL. D., Director U. S. Coast and Geodetic Survey, Washington, D. C.; Prof. B. F. Thomas, Ohio University, Columbus, Ohio; Prof. Thomas Gray, Rose Polytechnic Institute, Terre Haute, Indiana; Prof. A. E. Dolbear, Tufft's College, College Hill, Mass.; Prof. John Trowbridge, D. Sc., Harvard University, Cambridge, Mass.; Prof. F. E. Nipher, Washington University, St. Louis, Mo.; Prof. Sidney H. Short, Cleveland, Ohio; Prof. Henry Morton, Stevens Institute, Hoboken, N. J.; Prof. Brown Ayres, Tulane University, New Orleans, La.; Prof. John E. Davis, LL. D., University of Wisconsin, Madison, Wis.; Prof. A. P. Carman, Purdue University, Lafayette, Ind.; Prof. Lucian I. Blake, Ph. D., University of Kansas, Lawrence, Kan.; Charles F. Brush, Cleveland, Ohio; Dr. Channing, Pasadena, Cal.; Michael I. Pupin, Ph. D., Columbia College, New York, N. Y.; Prof. Elihu Thomson, Lynn, Mass.; Franklin L. Pope, Elizabeth, N. J.; George M. Phelps, New York, N. Y.; Frank J. Sprague, New York, N. Y.; Edward Weston, Newark, N. J.; Prof. William A. Anthony, Manchester, Conn.; Louis Duncan, Ph. D., Johns Hopkins University, Baltimore, Md.; Prof. Alex. Graham Bell, Washington, D. C.; Francis B. Crocker, Columbia College, New York, N. Y.; Nikola Tesla, New York, N. Y.; Thomas A. Edison, Ph. D., Orange, N. J.; Carl Hering, Philadelphia Pa.; T. Commerford Martin, New York, N. Y.; Prof. Edward L. Nichols, Ph. D., Cornell University, Ithaca, N. Y.; Prof. Edwin J. Houston, Central High School, Philadelphia, Pa.; Dr. William E. Geyer, Stevens Institute of Technology, Hoboken, N. J.; A. E. Kennelly, Orange, N. J.; Thomas D. Lockwood, Boston, Mass.; Louis Bell, Ph. D., Chicago; Prof. Charles R. Cross, Mass. Institute of Technology, Boston, Mass.; George A. Hamilton, Elizabeth, N. J.; Ralph W. Pope, Elizabeth, N. J.

THE CHICAGO ELECTRIC CLUB.

The annual meeting of the Chicago Electric Club was held on April 21st. The following-named gentlemen were selected for the ensuing year:

President, B. E. Sunny; first vice-president, F. B. Badt; second vice-president, Alex. Kempt; third vice-president, M. A. Knapp; fourth vice-president, W. B. Pearson; secretary, W. A. Kreidler; treasurer, F. S. Terry; managers, F. W. Parker, chairman; Geo. C. Bailey, E. Baggot, J. P. Barrett, W. J. Buckley, F. W. Cushing; F. E. Degenhardt, E. R. Gilman, J. J. Nate, C. H. Wilmerding; membership committee, C. C. Haskins, chairman; T. G. Grier, Geo. Cutter.

The old quarters on Adams street, which have been occupied during the last two years, will be deserted on May 1st, when the club will take possession of its new rooms on the northeast corner of Clark and Monroe streets.

CHICAGO ELECTRICAL ASSOCIATION.

The meeting of the Chicago Electrical Association, last week, was cut rather short by the sudden departure of the audience. Mr. F. R. McBerty was reading a paper on the sparking of dynamos and the members were getting warmed up by his treatment of this fiery subject, when it was found that the upper two stories of the building were not only sparking but blazing, and the meeting adjourned *sine die.*

The electrical brethren all got out unscathed. A group of them was afterwards seen watching the work of the "boys in blue," and discussing the uses of electricity for operating extinguishers, and proposing measures to prevent the sparking of buildings.

MEETING OF LA SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.

At the meeting which took place on the 2d of March, 1892, the president, M. Joubert, reminded the members that the elections for the committee had taken place during the previous month, and that M. Carpentier had been elected president for next year.

M. C. Rechniewski then made a communication on the dissipation of heat in the armatures of dynamo-electric machines. The author has made on this subject a series of experiments. In one machine, having an output of 3,300 watts, in order not to exceed a maximum of 50° C., copper of 440 cubic centimetres, and iron of 1,100 cubic centimetres, was necessary. The total cooling surface was 950 square centimetres. For a machine with a ring armature, to obtain the same conditions, it was necessary to have a cooling surface of 5.73 square centimetres per watt. With a multipolar machine, having a total cooling surface of 7,440 square centimetres, giving 33 amperes at 120 volts, and running at 490 revolutions per minute, M. Rechniewski has found that it is necessary to have a cooling surface of 3.8 square centimetres per watt.

Letters to the Editor.

A PROPHECY OF INDUCTION RAILWAYS.

Referring to your April 20, article on page 411, in connection with an induction electric railway system, I wish to call the attention of your readers to the last paragraph but one of a lecture which I delivered before the Franklin Institute in Feb. 1891, wherein I prophesy an induction system of this kind in the following words: "On the asphalt highways, underlaid in certain lines, separate from the horse-tracks, with induction plates, glide tricycles and other low carriages of analogous light and elegant construction—their motors running at will, when brought over the sunken wire-bound plates."

What I had in mind at the time was of course but a modification of the transformer principle, the primary coils thereof being laid in the ground, as close as possible to the surface, and the secondary coil being carried upon the car. I am not even sure that this suggestion was original with me at the time, as I might have seen a hint of it published somewhere, but cannot be certain upon this point. I do not know what claims are made in regard to the present system in question, but it seems very certain that the inherent principle involved is not entirely new.

OBERLIN SMITH.

BRIDGETON, N. J., April 28, 1892.

Obituary.

EUGENE H. COWLES.

EUGENE H. COWLES, eldest son of the late Edwin Cowles, who was the editor of the Cleveland *Leader*, died on April 21, at El Paso, Texas, where he had gone for his health. Hemorrhage of the lungs caused his death. Mr. Cowles was 38 years old. He was a director and secretary of the Leader Printing Company, and manager of the Cowles Electric Smelting and Aluminum Company, of Lockport, N. Y. Together with his brother, A. H. Cowles, he invented the Cowles process of making aluminum by means of electrical heat, the discovery marking a distinct step in metallurgic progress. He also invented improvements in the overhead trolley system of propelling street cars by electricity.

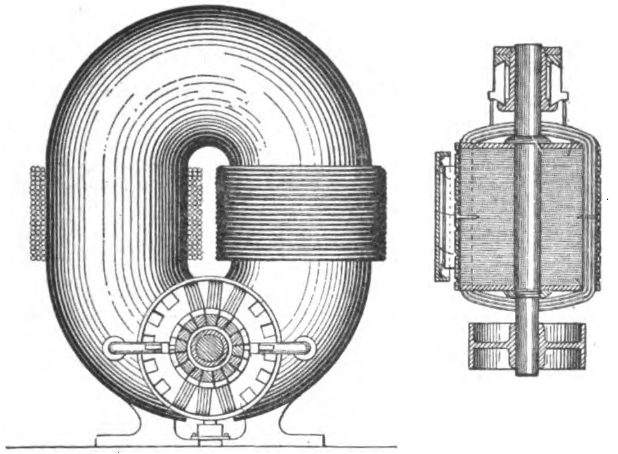
Personal.

DR. F. A. C. PERRINE, who has for some time past been connected with the electrical wire interests of the Roeblings at Trenton, N. J., is resigning there and will go to Boston, where he will join the forces of the Germania Electric Company.

Patent Notes.

A "SHORT" DYNAMO DISPENSING WITH AIR SPACE AND JOURNALS.

IN order to diminish the magnetic resistance of the interpolar space, and also to increase the relative number of the lines of force passing through the armature, Mr. Sidney H. Short, of Cleveland, Ohio, has invented the form of generator shown in the accompanying ilustrations, where Fig. 1 is a side elevation of the machine, partly in section, and Fig. 2 a longitudinal section of the armature and lubricating cup. As will be seen, the armature, covered with a continuous ring of iron, revolves between the pole-pieces which act as a journal, means for lubrication being provided. The field magnets can thus be reduced in size and excited with a less number of ampere turns, while exercising an equal effect in the machine, and are so placed that their action is opposed to that of gravity, which minimizes the pressure on the bearing surfaces.



FIGS. 1 AND 2.—NEW "SHORT" DYNAMO.

This is a most radical departure from existing methods of dynamo construction, and the test of its practical utility will be awaited with interest.

MR. H. F. PARSHALL has been transferred from the electrical engineering department of the Edison General Electric Co. to the Thomson-Houston Works at Lynn, as designer of apparatus and electrical engineer in the railway and power department.

EXTENSIVE ELECTRIC RAILWAY WORK NEAR NEW YORK CITY.

FIVE electric railway companies have just been incorporated in this State to operate in the "annexed district" of New York City. The directors of these companies are Howard Carroll, Thurlow Weed Barnes, George C. Clausen, James McNaughton, Frank M. Pitton, George H. Laurence, Frank T. Scott, William H. Jasper and Charles E. Coddington. A majority of the stock in each company is taken by Carroll and Coddington.

The first of the five is the William's Bridge and Westchester Traction Railroad Company, with a capital of $80,000 and a length of four miles. The termini of this road are to be at the junction of the Bronx River and Olive avenue in the village of William's Bridge and the junction of Main street in the village of Westchester and Westchester Creek.

The second is the Suburban Traction Company, with a capital of $150,000 and a length of five miles. The termini of the main line are the junction of Bronx River and the southern turnpike of Harlem road and the junction of Main street in the village of Westchester and Westchester Creek.

The third is the Hopefield and Westchester Traction Company, with a capital of $100,000 and a length of seven miles. The termini are the intersection of Fifteenth avenue and Third street in the village of William's Bridge and the junction of Long Island Sound with the new road between the Eastern Boulevard and Long Island Sound.

The fourth is called the West Farms and Westchester Traction Company, with a capital of $80,000 and a length of three miles. Its termini are the junction of the Bronx River and the new West Farms Road and the junction of Main street in the village of Westchester and Westchester Creek.

The fifth is called the Van Nest, West Farms and Westchester Traction Company, with a capital of $150,000 and a length of five miles. The termini of its main line are the junction of the Bronx River and the new West Farms Road and the junction of the main street in the village of Westchester and Westchester Creek.

LANDING THE FRENCH CABLE.

THE joint resolution granting to the French Cable Telegraph Company, of Paris and New York, the right to land a cable on the shores of Virginia and South Carolina, thence to go from Cuba to San Domingo, was the subject of a hearing last week before the Senate Committee on Commerce, at which Secretary Blaine, members of the French Legation in Washington, and attorneys for the company were heard. Secretary Blaine made a vigorous protest against the passage of tho resolution, urging that it should be killed in committee. It would, he said, prevent the growth of an American cable system to Brazil.

PLANTÉ AND MODERN ACCUMULATORS.[1]

IT is strange that so much of Planté's work has been ignored and then rediscovered. It is often thought that charging at 2½ volts or more is a modern practice. Planté states that 1½ times the E. M. F. of a Bunsen is all that is necessary. That is to say, he always employs a high enough pressure to charge quickly. He mentions the liberation of gas, and explains when it shows that a cell is charged to saturation and when it does not. Planté did not regard his cells as being solely for filling slowly and emptying quickly; he pointed out that they might be used for charging quickly and discharging slowly. He was also aware of the high initial pressure of a cell after charging and its sudden drop. What is still more remarkable is that Planté pointed out that to keep a cell right it must be charged fully and kept charged. He recommends Bunsens for charging and Daniells for keeping fully charged. He also points out how a fully charged cell protects its own plates from local action. Most of these properties of batteries had to be rediscovered, Messrs. Drake and Gorham and others finding them out gradually. Planté's book went out of print in 1881, and the English translation did not appear till 1887, so that though every electrician knew of Planté, few knew what he had actually done.

The remarkable constancy of pressure or discharge of a Planté cell is almost unknown in modern practice. It is, however, nearly reproduced in the Epstein cell, which will give practically its whole discharge with an exceedingly small fall of pressure.

THE ELECTRIC PLANT ON LEAK'S ADVERTISING CAR.

THE ROCKFORD MFG. CO., of Rockford, Ill., furnished some time ago a small lighting plant, comprising a boiler, six h. p. engine and 60-light dynamo for Leak's private car, which is now in Chicago, and parties interested in the products of Place county, Cal., are invited to inspect the same. The plant runs 65-lights and has done excellent work and Mr. M. Leak is enthusiastic in its praise.

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[1] *Industries.*

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED APRIL 19, 1892.

Accumulators:—

Secondary Battery, H. E. Dey, 473,146. Filed Sept. 10, 1890.

Claim 2 follows:

A negative plate for secondary batteries composed of finely divided or spongy lead having its edges compressed or compacted and raised above one face, forming a flange or protecting edge along the sides and bottom of the plate.

Secondary Battery, H. E. Dey, 473,147. Filed Sept. 17, 1890.

Claim 1 follows:

The combination in a secondary battery with the positive and negative plates of the same, of metallic partition plates interposed between contiguous active plates and provided with thickened or flanged edges and packing between the edges of said partition plates.

Alarms and Signals:—

Signaling System, H. A. Chase, 472,983. Filed Nov. 6, 1891.

A signaling system capable of transmitting a given number in a series of short impulses and a series of long impulses whereby two distinct purposes may be indicated.

District Telegraph Box, C. Selden, 473,024. Filed June 15, 1885.

Consists in the combination with a district signal apparatus of an indicator operated by an electromagnet having two coils connected respectively with the line and the ground circuit.

Electrical Annunciator, T. W. Lane, 473,121. Filed Dec. 15, 1890.

Employs an electrical set-back composed of a magnet, armature having a spring connection, supporting posts therefor and a suitable locking device.

Railway-Signal, U. S. Jackson, 473,190. Filed Oct. 21, 1891.

Anelectric block system, adapted to be operated both mechanically and electrically.

Electric Railway Signal, J. M. Brasington, 473,288. Filed July 24, 1891.

A signal for a locomotive cab adapted to warn the engineer of a break or obstruction on the track.

Conductors, Conduits and Insulators:

Conduit and Trolley for Electric Railway Systems, S. C. Carll and J. W. Phillips, 472,982. Filed Feb. 19, 1891.

A double-wire conduit and trolley for electric railways.

Conduit for Electric Wires, C. H. Wilson, 473,044. Filed Sept. 19, 1889.

Claim 8 follows:

A subway for electric conductors formed of sections of pipe, the different sections being joined by a flexible joint and a T forming a part of said pipe, in combination with a lateral extending from said T.

Electric Cable, W. H. Sawyer, 473,267. Filed Oct. 27, 1891.

Consists of a series of wires interbraided with fibrous material into tubular form.

Electric Cable, W. H. Sawyer, 473,351. Filed Oct. 27. 1891.

Similar in construction to No. 473,267, but having an air-space through the centre.

Electric Cable, W H. Sawyer, 473,352. Filed Oct. 27, 1891.

Similar to No. 473 351.

Electric Cable, W. H. Sawyer, 473,353. Filed Oct. 27, 1891.

Similar to No. 473,351.

Dynamos and Motors:—

Armature Core for Electric Motors, D. Pepper, Jr., 473,077. Filed July 24 1891.

A core built up of sections, having at their ends tongues and enclosed recesses with a spider having arms arranged to grasp and centre the interlocked sections.

Armature Ring, D. Pepper, Jr., 473,078. Filed Dec. 3, 1891.

An armature ring adapted for use in connection with the core described in No. 473,077.

Commutator Brush, G. Meyer, 473,195. Filed June 6, 1891.

Commutator brush having various independent points of contact, flexibly secured so that the breaking of one will in no way affect the other for the purpose of preventing sparking and wearing of the commutator.

Armature for Dynamo-Electric Machines, S. H. Short, 473,363. Filed June, 10. 1891.

Employs a foundation ring grooved circumferentially on its inner periphery and a laminated core, a portion of the folds of which are of less width than that of the foundation ring.

Armature for Dynamo-Electric Machines, S. H. Short, 473,364. Filed June 19, 1891.

Claim 2 follows:

An armature for a dynamo electric machine provided with a branch conductor for a commutator connection united to the bobbin wire by a flat line joint which leaves the bobbin wire practically continuous for winding.

Armature for Electric Generators or Motors, S. H. Short, 473,366. Filed June 24, 1891.

A tooth armature having magnetic material projecting over the outside of the rectangular bobbin recesses so that a narrower slot is left between them through which the bobbin wire may be introduced for winding.

Dynamo-Electric Machine, S. H. Short, 473,367. Filed June 24, 1891.

Claim 1 follows:

A dynamo-electric machine having the armature turning in sliding contact with the field poles.

Galvanic and Thermo-Electric Batteries:—

Electric Battery, J. E. Emley, 473,386. Filed Jan. 27, 1891.

Claim 2 follows:

In an electric battery an electrode formed of two discs arranged parallel with each other and suitably secured together, an electrode of opposite polarity, consisting of a disc mounted upon a shaft and arranged to rotate between the discs of the first-named electrodes, means of rotating said shaft and means for conducting the electricity from the electrodes,

Lamps and Appurtenances:—

Electric Arc Lamp, O. Patin, 473,076. Filed April 11, 1891.

An arc lamp adapted to work either in series or shunt and with continuous or alternating currents, and producing the lighting and regulating by means of a simple coil mounted in shunt with the poles of the arc.

Incandescent Electric Lamp, A. C. Carey, 473,208. Filed Dec. 1, 1891.

Provides means for renewing the carbons of incandescent lamps when broken.

Rheostat, A. C. Carey, 473,209. Filed Jan. 27, 1892.

Provides means for controlling the brilliancy of incandescent lamps by interposing rheostats in the individual circuits.

Electric Light Support, G. M Kim, 473,229. Filed Oct. 10, 1891.

Lamp Shade and Holder for Incandescent Lamps, G. F. Seavey, 473,240. Filed Aug. 6, 1891.

Electric Arc Lamp, T. E. Adams, 473,283. Filed July 8, 1890.

Has for its object to provide an adjustment that will remain fixed and certain for any given current and cannot be changed or modified by the trimmer or attendant.

Incandescent Electric Lamp Socket, C. R. Arnold, 473,373. Filed Dec. 17, 1891.

A spring socket for incandescent lamps subjected to vibration or jar.

Metal-Working:—

Heating and Welding by Electricity, H. Howard, 473,003. Filed Oct. 21, 1891.

A welding system in which the material to be welded forms one pole, and a pencil the other pole of an electric arc.

Metallurgical:

Electrode, P. L. T. Heroult, 473,398. Filed Aug. 8, 1889.

An electrode for metallurgical works consisting of carbon, a plate of metal extending its entire length and means for fastening them together.

Method of Producing Metallic Zinc, P. C. Choate, 473,186. Filed Jan. 5, 1891.

Consists of forming an electrolytic solution by dissolving in dilute sulphuric acid oxide of zinc in the state of fume free from the lighter soluble impurities and then treating the solution by electrolysis.

Apparatus for Producing Aluminum or other Metals, P. Heroult, 473,118. Filed Dec. 27, 1887.

Electrode for use in Electro-Metallurgical Processes, P. Heroult, 473,117. Filed Sept. 8, 1889.

Consists of carbon strips secured together in a single block and a metal combined therewith in order to lower the electrical resistance of the electrode when in use.

Electrolytic Apparatus for Separating Gold and other Metals from their Ores, G. J. Atkins, 473,105. Filed Apr. 28, 1891.

Ore Separator, S. G. Elliott, 473,066. Filed Aug. 19, 1890.

Miscellaneous:—

Electric Clutch, P. W. Willans, 473,042. Filed July 21, 1891.

Contains an iron ring provided with a series of horns having metal rings of low resistance, circuit windings between the horns and an iron cross-head rotating within the ring and having circuit wires wound upon its opposite extremities parallel to its axis of rotation.

Lightning Arrester, M. M. Wood, 473,045. Filed June 20, 1891.

Consists of a ground wire and a wire leading to the line.

Claim 1 follows:

The combination of a ground wire with a wire leading to the line and a connecting circuit from line to ground, consisting in part of a substance of high resistance and a substance of low resistance, the two opposed to each other and the one substantially surrounding the other.

Electric Lock, C. H. Crockett and C. C. Allen, 473,061. Filed May 5, 1888.

Machine for Making Insulated Magnetic Coils, C. E. Lipe, 473,123. Filed Oct. 8, 1890.

Electro-Therapeutic Heating Pad, F. H. Soden, 473,133. Filed Sept. 1, 1891.

Ship's Log, R. T. Hall, 473,222. Filed Sept. 7, 1891.

Consists of a flexible diaphragm below the water line, a resistance coil, connections between its pole-pieces and the diaphragm, an electric generator and an indicating device for the variations of resistance.

Electric Odometer and Speed Indicator, W. A. Phillips, 473,341. Filed March 19, 1891.

The combination with the anchor or detent of the escapement wheel of the register-hand-actuating-gear mechanism, the armature lever having one end normally resting upon said anchor at its elevated end, and an electromagnet having electrical connection with the car wheel axle.

Electric Stop Motion for Looms, J. C. Brooks, 473,378. Filed May 14, 1891.

Railways and Appliances:—

Hanger for Electric Wires, T. Imeson, L. D. Tibbets and C. L. F. Kellogg, 473,158. Filed Feb. 2, 1892.

A trolley-wire hanger consisting of two interlocking jaws in combination with a pivot plate.

Converter System for Electric Railways, M. W. Dewey, 473,253. Filed June 25, 1889.

See THE ELECTRICAL ENGINEER of April 20th.

Multiple Arc Railway System, S. H. Short, 473,361. Filed Jan. 8, 1890.

Provides a series of independent blocks of conductor and automatic cut-out devices combined with each block.

Trolley Switch, S. H. Short, 473.362. Filed Jan. 8, 1890.

An automatic switch operated by the trolley itself.

Gearless Motor for Electric Railway Cars, S. H. Short, 473,365. Filed June 24, 1891.

Relates to street car motors in which the armatures are axially placed with reference to the driving axles and directly connected therewith.

Gearless Propelling Mechanism for Electric Railway Cars, S. H. Short 473,368. Filed July 6, 1891.

Claim 1 follows:

The propelling mechanism for an electric railway car comprising, in combination with the driving axle, an armature mounted on said axle and rotating therewith, and field magnets provided with journal bearings at the periphery of said armature.

Switches and Cut-Outs:—

Electric Switch, F. H. Soden. 473,132. Filed July 2, 1891.

Permits a ready and convenient use of a hand-operating switching device in connection with any desired number of contacts.

Electric Switch, F. H. Soden, 473,134. Filed Oct. 26, 1891.

Similar in its object to 473,132.

Electric Switch, E. H. Johnson, 473,228. Filed Aug. 25, 1891.

A switch designed especially for currents of considerable quantity and high tension; the construction being such that dangerous heating is practically impossible for the reason that should the contacts begin to heat they become more firmly pressed together by the expansion of the metals, thus automatically increasing their carrying capacity.

Cut-Off for Electrical Machines, J. P. Woolley, 473,282. Filed Nov. 23, 1891.

Claim 1 follows:

The combination with an electromagnet, of a weight normally suspended under, and supported by, said magnet and a cord passing over pulleys and connecting to a circuit breaker.

Electric Switch, E. P. Warner, 473,435. Filed Feb. 2, 1889.

Consists of two pairs of springs mounted on the opposite side of an insulating block and a pivoted shifter whereby either pair may be separated from the lamp circuit terminals and connected together, while the other pair close upon the terminals.

Telegraphs:—

Electric Indicating System and Instrument, H. J. Haight, 473,174. Filed Dec. 15, 1891.

A system for the purpose of enabling the transmission of a variety of data concerning each of several subjects.

Telephones and Apparatus:—

Testing Apparatus for Trunk-Lines of Telephone Exchanges, C. E. Scribner, 473,089. Filed March 13, 1885.

Enables the operator wishing to connect with a trunk-line to make a quick test to determine what trunk lines are free.

Telephone Receiver, E. C. Hess, 473,256. Filed July 1, 1891.

A receiver adapted to be applied to both ears at once.

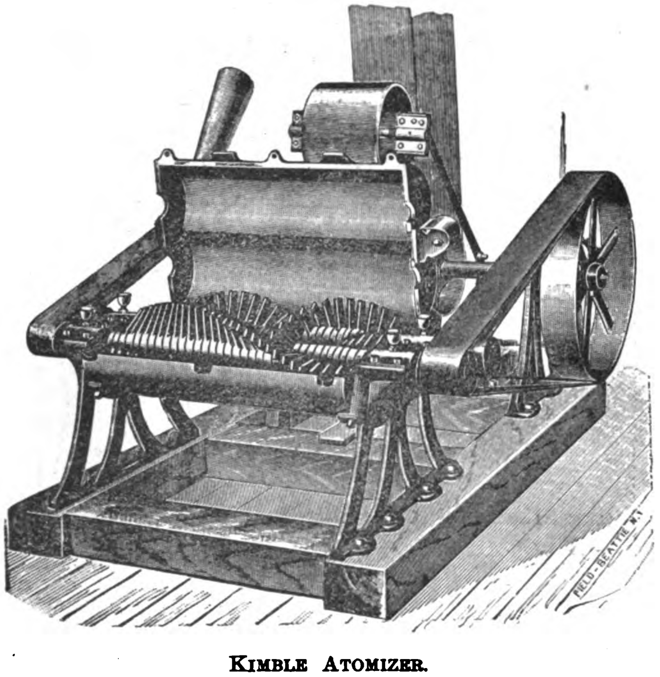
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

An ad. is a good search light to find new customers with.

THE KIMBLE ATOMIZER.

We present on this page an excellent cut of the Kimble atomizer showing its interior very accurately. The atomizer is set up with back countershaft and tightener and is belted ready to attach power. The power required to run one machine is about 10 h. p. The space occupied by the machine is about 5 feet by 7 feet. Attention may be called to the two shafts upon which are set a number of beaters or fingers. These are made of a superior grade of gun-metal. A key seat is cut in each beater, they are then put in place and firmly fastened with a nut holding them firmly. It will be noticed that the belt on shaft No. 1 in running rides off shaft No 2, both running in the same direction and at a speed of 6,000 revolutions per minute. The fingers on shaft 2 in revolving pass through the fingers on the other shaft and *vice versa*. On shaft 2 the fingers are placed spirally, giving them a tendency to carry the material from left to right in the machine at a velocity of 18,000 feet per minute; while on shaft 1 the fingers are put on the reverse way, carrying the material in the opposite direction at a velocity of 9,000 feet per minute. It will be seen by this that we have two opposing parts running in opposite directions at a wonderful velocity. This machine is an almost indispensable article to those whose business necessitates the atomizing of mica, asbestos, graphite, carbon, aluminum earths, oxides. etc. The R. R. Mica Lubricant Company, 444 Pearl street, New York, are the manufacturers and furnish a nicely illustrated and descriptive catalogue.



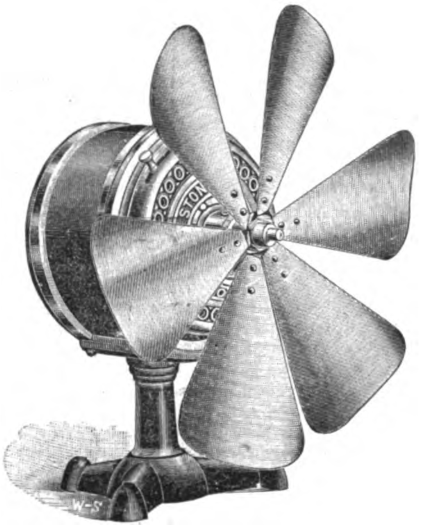
Kimble Atomizer.

THE MESTON ALTERNATING FAN MOTOR.

The accompanying illustration shows the 1892 model of the Meston alternating fan motor, manufactured by the Emerson Electric Mfg. Co., of St. Louis. The fan is 12 inches in diameter, and has a variable speed up to 2,000 revolutions per minute. The motor takes a current of 1.8 ampere and runs on a 52-volt circuit. It is finely finished in polished bronze and black enamel, and is thoroughly artistic in design. The base or stand is a graceful tripod, furnished with soft-rubber cushions, which gives a secure footing for the motor, and prevents all noise by vibration.

The polished bronze castings which serve as bearings for the armature shaft, are of highly ornamental design, and are extremely strong and substantial. The motor is completely enclosed, no wire being visible, nor any of the working parts exposed to possible injury. At the same time it is easily accessible, as the end covers may be removed entirely in a moment, and the armature taken out without disconnecting any wires or disarranging any adjustment.

The regulating device is exceedingly simple. Not only can the speed and the consumption of current be varied instantly at will, but the direction of rotation can be changed by a further movement of the same button. The armature, commutator, brushes and holders are of the finest workmanship and are made to last, while the self-oiling bearings form a special feature of the motor, and cannot throw oil.



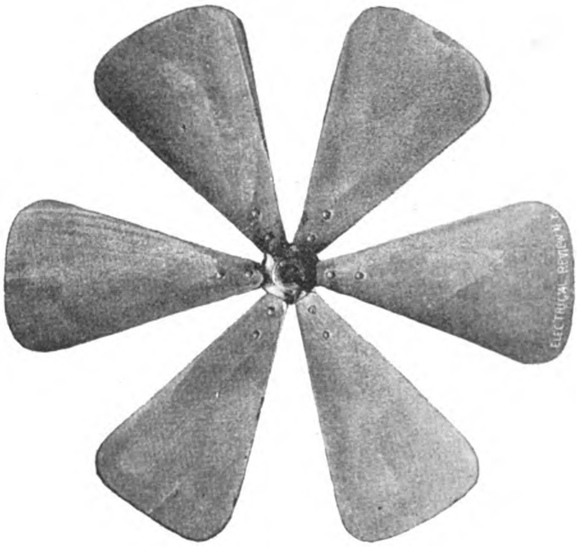
Meston Alternating Fan Motor.

The Emerson Electric Mfg. Co. are overrun with orders for this fan, and have been compelled, thus early in the season, to increase their facilities.

THE HOLMES, BOOTH & HAYDENS BALANCED FAN.

The accompanying illustration shows a brass fan for electric motors, recently introduced by Messrs. Holmes, Booth & Haydens, of this city, and Waterbury, Conn.

Experience has been availed of, to produce a fan that will distribute the breeze from it, and not throw it out like a gleam from a search light, as many fans do. The high speed of a motor fan requires absolute mechanical efficiency to ensure safety, and as these fans are finished by the lamp department of Holmes, Booth & Haydens, an elegance is secured which makes them decidedly ornamental. They are of all sizes from 5 to 15 inches, and lacquered, or silver-plated. Fan guards are also made for any size of fan.



Balanced Electric Fan.

THE STEARNS MANUFACTURING CO.

We learn that the Stearns Manufacturing Co., of Erie, Pa., have now acquired by purchase the remaining franchises of Woodbury, Booth & Pryor and the Woodbury Engine Co., of Rochester, N. Y., including all patterns, patents, special tools, trade marks, good-will, etc., etc. This puts into the hands of the Stearns Company not only the sole ownership of the Woodbury high-speed automatic steam engines, which they previously purchased, but also the "Woodbury Medium-Speed Automatic Engines" and the means of producing both.

The name "Woodbury" has been for forty years synonymous with good steam engines, and with something over three thousand of the two classes here named, all bearing the "Woodbury" earmarks, to point and refer to, the Stearns Company ought to be satisfied they have made no mistake in adding the medium-speed automatic Woodbury to the Woodbury high speed they have already pushed to the front rank of its class.

THE "VICTOR" CYLINDER AND REGISTER GATE TURBINES.

The electrical transmission of power over long distances gives an immediate value to water-powers, which have hitherto remained unimproved because located more or less remotely from transportation lines, or because the local demand for power was not sufficient to justify the expense. The country abounds in such water-powers, many of them of immense magnitude, and it is only a question of time when they will be improved and the power generated, transported by wires to the surrounding cities and towns utilized for light, heat and power. In view of these facts a new and increased interest attaches to the question of turbines, their construction and application.

With a commendable determination to meet all reasonable demands of customers, and maintain their position as manufacturers, the Stilwell & Bierce Manufacturing Company, of Dayton, Ohio, have perfected and introduced their "Cylinder Gate" Victor turbine, which has been carefully tested in the Holyoke testing flume with gratifying results, not only as to high efficiency but as to power, which was proved to be larger for its diameter than any other known turbine. The tests also developed a remarkably high efficiency at all degrees of gate opening, from one-half to full gate.

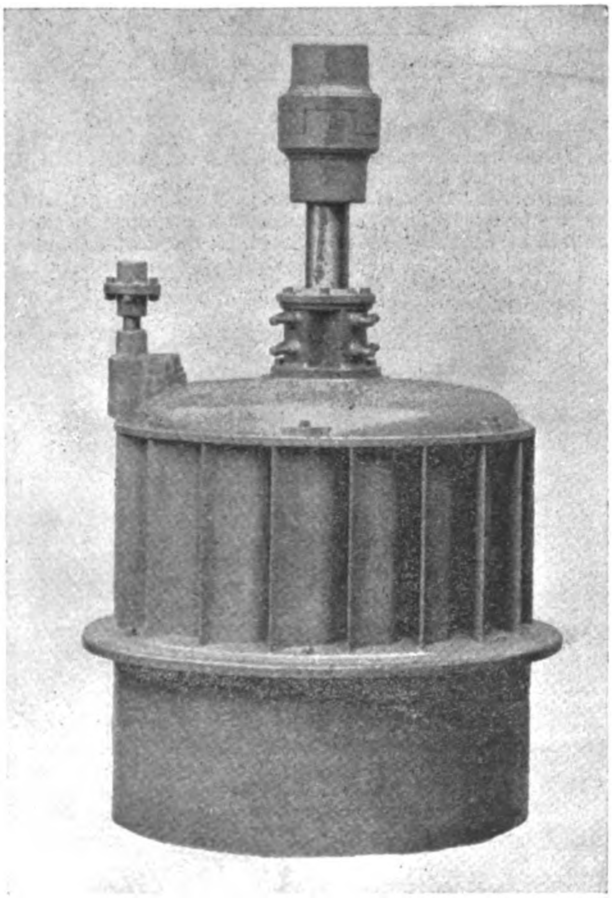


Fig. 1.—The "Victor" Cylinder Gate Turbine.

The accompanying illustrations show both styles of the "Victor" turbine made by this company, Fig. 1 showing the "register gate" and Fig. 2 the "cylinder gate." A separate catalogue is published for each one of these wheels, and will be furnished by the manufacturers to interested parties on application.

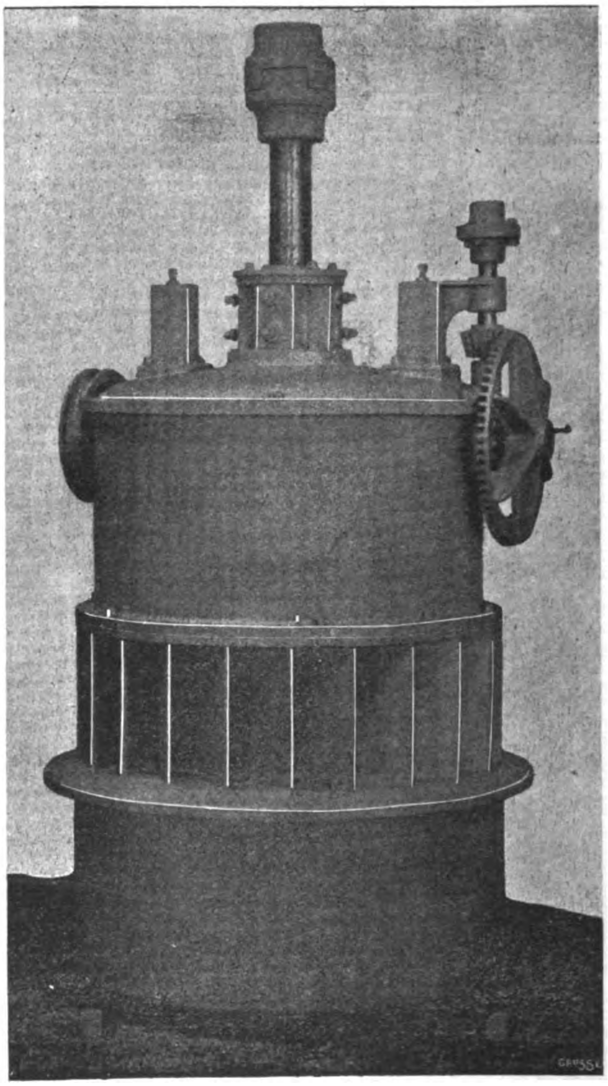


Fig. 2.—The "Victor" Register Gate Turbine.

These turbines are built in sizes ranging from six to sixty inches in diameter, on vertical or horizontal shafts, in a great variety of plans adapted to all classes of establishments, from the simple country mill requiring 50 h. p. or less up to the mammoth cotton mills, paper mills or electric plants, consuming many thousand horse power. The Stilwell & Bierce Manufacturing Company are also provided with a very complete assortment of patterns of all kinds of modern appliances for transmitting power, and make a specialty of complete water-power plants for all purposes.

A "SHORT" RAILWAY PLANT FOR SIAM.

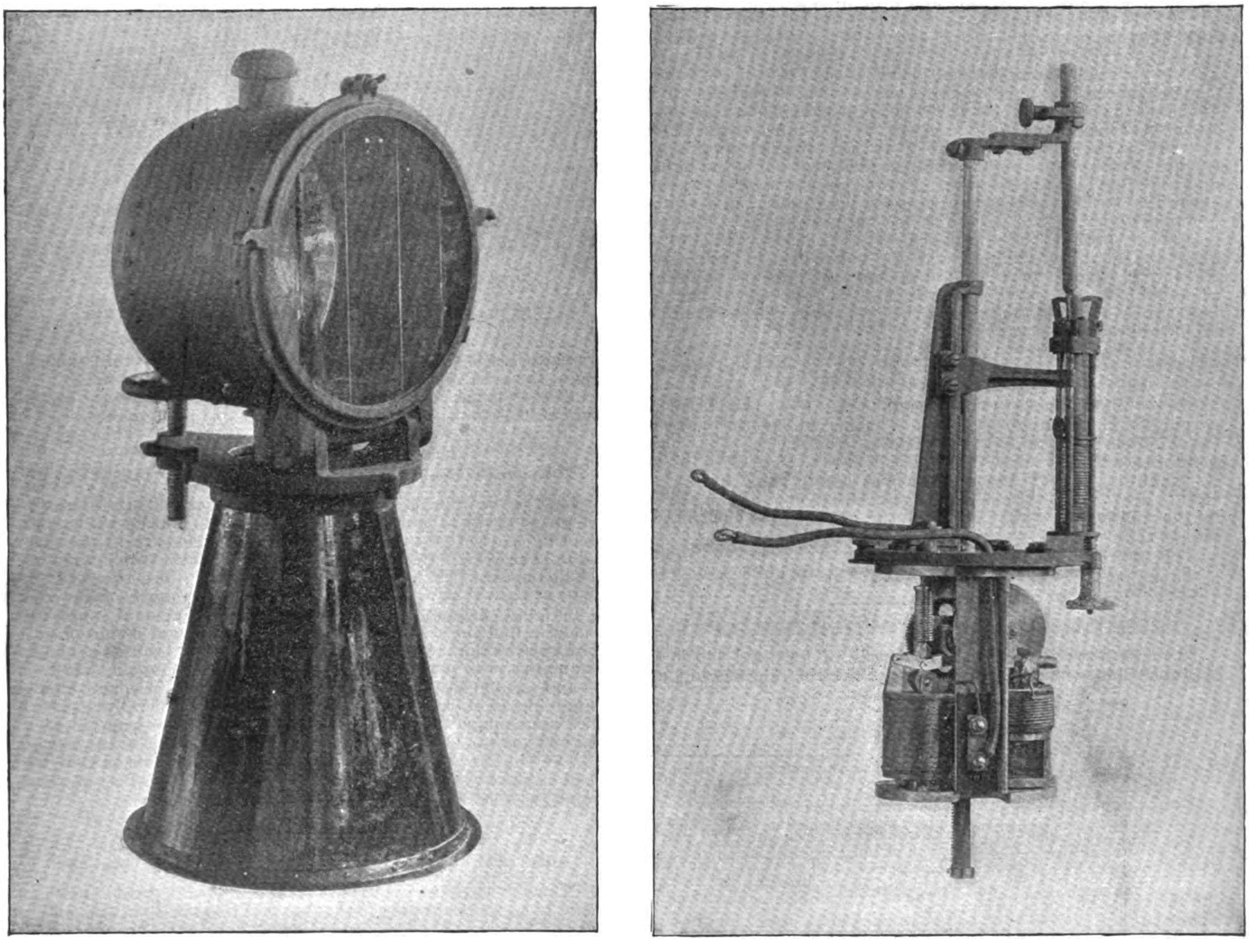
The Short Electric Railway Co. are now shipping to Siam the entire installation for the first electric tramway in that country. The plant goes to the Bangkok Tramways Co., who will equip a road 6 miles long, 6 foot gauge. The road is practically level and most interesting throughout its entire length, crossing fourteen of the many canal bridges in Bangkok. Teakwood poles will be used in construction throughout—in fact, all wood used in connection with the installation will be teakwood. The plant includes two generators, two steam plants complete, six car equipments and extra parts to last for six months.

The order is the outcome of the visit to this country of Mr. Aage Westenholz, who made a thorough examination of electric railway apparatus, both in Europe and in this country, visiting all the large manufacturing companies and the most succesful of their plants. Mr. Westenholz is the leading engineer in Siam.

NEW EDISON SEARCH LIGHT PROJECTOR.

WE give below description and illustrations of the new "D" type search light projector, recently designed by the Edison General Electric Co. Fig. 1 shows the side and front view, and Fig. 2 the lamp mechanism, which will give a good idea of the general style of the projector.

The lamp is designed to run on an incandescent circuit with a potential of 50 to 55 volts, at which it requires about 15 amperes and gives a light of 3,000 c. p. A suitable resistance is placed in series with the lamp to permit of its adjustment to the potential of different circuits upon which it may be used. The lamp is both self-regulating and self-focusing. The lower carbon is pressed upwards against fixed stops by a spiral spring, thus maintaining the arc in the focus of the reflector. A hand adjustment is provided for raising and lowering these stops, by which the vertical position of the arc can be altered. The upper carbon falls by gravity, its descent being perfectly regulated by the lamp mechanism, so that great steadiness of light is obtained. The negative carbon being placed a little back of the line of the positive carbon, a crater is thus formed on the side of the latter and nearly all the light is thrown toward the reflector. A ventilating hood on the top of the drum provides an escape for the heat.



FIGS. 1 AND 2.—NEW EDISON SEARCH-LIGHT PROJECTOR.

The drum is of iron and 18 inches in diameter. A highly polished silver plated parabolic reflector 17 inches in diameter, with five-inch focus is mounted at one end of the drum on a finely threaded screw-piece, by which it can be moved to or from the arc. By this means the light can be concentrated in a narrow beam or be widely diverged. The usual focus in projectors of this class is from two inches to three inches, and considerable advantage is derived by the increase in focus obtained in this projector. A fine hole is drilled through the screw-piece on which the reflector is mounted, through which the exact position of the arc is shown on a small piece of ground glass.

The drum is provided with vertical and horizontal adjustments. The vertical adjustment is effected by means of a hand wheel operating a double-threaded screw. It has a vertical movement of 30 degrees, 15 degrees above and 15 degrees below the horizontal line, which is sufficient for ordinary purposes. The horizontal adjustment permits a complete revolution of the drum upon its base, so that the light can be readily thrown toward any point of the compass. By means of a clamp screw the drum can be quickly fastened in any position.

Provision is made for a cord attachment in order that the projector may be operated from a distance if preferred, as for instance from the pilot house, when the projector is set at the bow or any other part of a vessel. The connecting terminals for the lamp are placed on opposite sides of the drum; the conductors can therefore be brought up in the form of spirals without risk of their "crossing."

The height of the projector is 48½ inches and the centre of the reflector is 36 inches above the bottom of the base. The floor space required for the base is 22 inches in diameter. This projector is simple, strong and substantial, and all the parts have been arranged with a view to secure efficient and easy operation. It is estimated that in clear weather the beam of light will have an effective range of 2,000 yards. The compactness of the entire apparatus renders it especially advantageous for use on vessels, wharfs, etc.

BIDS WANTED FOR AN ELECTRIC RAILWAY AT NIAGARA.

MR. W. T. JENNINGS, engineer, informs us that on Monday, May 2, plans, profiles and specifications will be on exhibition at the office of the Niagara Falls and River Railway, Niagara Falls, Ont., upon which tenders will be received up to May 10, 1892, for the complete electrical equipment of the line as far as at present required.

BLOCK SIGNALS ON THE NEW YORK CENTRAL.

An important step and one that is certainly in the right direction has been taken by the management of the New York Central and Hudson River Railroad. This is the adoption of a complete system of block signalling over their entire line between New York and Buffalo. After months of the most careful consideration and experimenting, they have finally decided upon the systems of signals they will use as more or less adapted to different portions of their lines. Contracts have been let, and the work is well under way. Mr. Theo. Voorhees, general superintendent of the New York Central, states that the contract for the work between this city and Poughkeepsie has been let to the Johnson Railway and Signal Company, and that portion between Poughkeepsie and Albany to the Union Switch and Signal Company. That portion of the company's lines between Albany and Buffalo required very careful consideration on account of the great amount of freight handled there. After special trips over this particular part of the system, a general plan of operations was decided on. It is proposed to establish absolute block stations for the passenger tracks between Albany and Buffalo at a distance of about three miles apart. These same stations will be used as a block for all freight tracks over the greater part of the entire distance. At each end of the divisions and at the approach to large yards, auxiliary electric signals will be placed on each side of the freight tracks between the signal stations, causing those portions to be operated under what might be termed a permissive block system. Between Albany and Buffalo there will be ninety-three signal stations, seventy-three of which will be iron bridges spanning the tracks. These will be light structures, and will carry the signals and the cabin of the operator. Every operator's cabin over the entire line will be equipped with Sykes instruments and will be operated under what is known as the "Sykes system." The system is expected to be completed between Albany and Buffalo about the month of August, and the entire line by the first of November. This work is to cost several hundreds of thousands of dollars, and the traveling public can now rest assured that the best known and absolute systems of protection will be installed regardless of their cost.

THE WADDELL-ENTZ CO.

The Waddell-Entz Electric Co., has just been incorporated in the State of West Virginia under the name of the Waddell-Entz Co., with a capital of $5,000,000. The incorporators are Montgomery Waddell, J. B. Entz, W. A. Phillips and A. Knauth. In 1890 the concern was incorporated under the statute laws of the State of New York with a capital of $100,000. Of the $5,000,000 capital stock of the new company, $2,500,000 will be represented by cash and $2,500,000 by patents.

It is proposed to greatly enlarge the factory of the company in Bridgeport, Conn., and, if found necessary, to build a new one altogether.

TERMINAL BLOCK FOR STATION SWITCHES.

The cuts herewith shows a new style of terminal block for station switches manufactured by the Electric Engineering and Supply Company, of Syracuse, N. Y. The wires are all brought in from the back, none whatever showing in front of the slate base, thus adding greatly to the neat appearance of the switch, and to the ease with which the wires can be inserted or withdrawn from the terminal blocks.

To insert the wire into the terminal, one has only to loosen the set-screw, and draw out the hollow terminal plug and solder the wire into it, when it can be readily pushed into the terminal block again, the set-screw tightened, and the operation is complete.

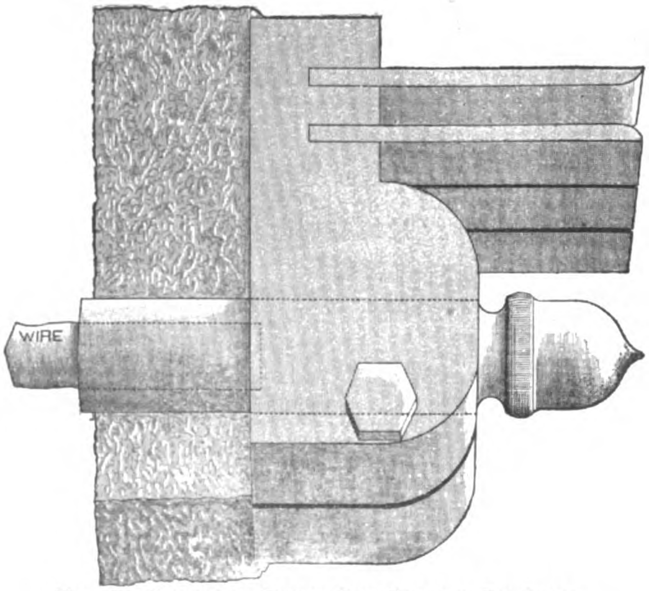


Fig. 1.—Terminal Block For Station Switches.

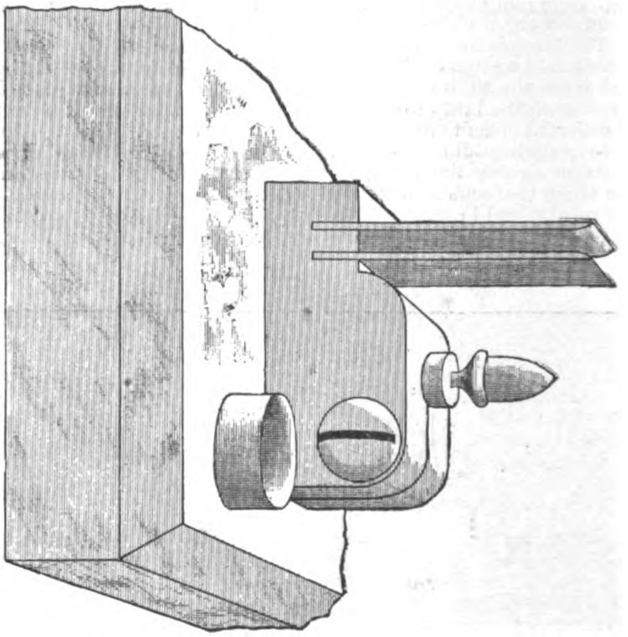


Fig. 2.—Terminal Block For Station Switches.

This style of terminal is now used by this company for all sizes of station switches from 35 amperes to 1,000 amperes.

A STORAGE BATTERY STATION AT HAVERFORD COLLEGE, PA.

Last week we published an editorial article with reference to the growing use of storage batteries in central station work, commenting on the fact that so little had been done here in the same field. The *Western Electrician* of April 30, has a very interesting article on the subject, with special details and illustrations of the plant at Haverford College, Pa. This plant was started as far back as 1887, but early sustained reverses, and the general inpression has been that the storage plant was in a moribund condition. It now appears that although the underground cables used as charging mains have virtually been abandoned, the company has gone on and during the last year has built overhead lines, and is now supplying about 3,000 lights. The batteries are generally placed in the basements of the houses, and each set supplies from three to ten residences. The batteries of the Accumulator Co. and apparatus of the Electro-Dynamic Co. are used. The success that has been attained with this small plant is a fair indication of what might be expected on a larger scale.

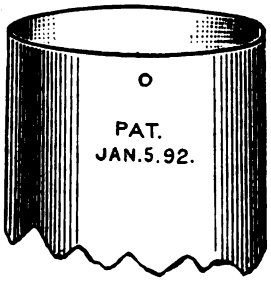
ELECTRIC RAILWAY DEVELOPMENT IN NEW ORLEANS.

New Orleans is practically the last of the great American cities to adopt the trolley, but it has had to come to it, and a large plant is now to be put in by the New Orleans and Carrollton Railroad Company. The road will be several miles long, and the change from mules will be made as quickly as possible. The electrical equipment will comprise 50 cars of the Thomson-Houston system, the cars being supplied by the St. Louis Car Company. Girder rails, 72 pounds, Johnson make, will be supplied by W. Kington, of Atlanta; 50-pound T-rail by the Pennsylvania Steel Co.; and 60-pound duplex by the Duplex Rail Company. The overhead construction will be done by J. G. White & Co., of New York, and the Ansonia Company's wire will be used. The steam plant will include three Corliss engines of 300 h. p. each. J. Hernandez is president of the road; W. V. Crouch, secretary; and C. V. Haile, superintendent. The consulting engineer for the whole work is Mr. A. Langstaff Johnston, who has already done so much of the best electric railway construction in the South.

Congdon, Bliss & Daniels, of Washington, D. C., have taken the agency for the Dayton Fan and Motor Co., of Dayton, Ohio, and have already sold about $1,600 worth of these motors during the past four weeks, ranging in size from one to four horse power.

THE HOLE IN THE JAR.

We show herewith a little patented device, controlled by Messrs. J. Jones & Son, of this city. The idea, while simple, is of value, and is used on all gravity cells put out by this company. It is only a hole drilled in the side of the battery jar, through which passes the wire attached to the copper in the cell. This hole prevents any strain to which the wire may be subjected, being communicated to the copper, and effectually prevents the displacement of the electrode. This renders the elements of the battery permanent at all times. Of course in upsetting the battery when it is to be refilled, this device plays no part at all.



"The Hole in The Jar."

KEYSTONE ELECTRIC CO.

Although the activity of large electric manufacturing concerns in the East and West is well known, people are quite likely to underestimate the amount of work turned out and the large number of important sales made by companies whose headquarters are in neither New York nor Chicago. The Keystone Electric Works of Erie, Pa., for instance, are meeting with surprising success, and now that they have launched upon the market a practical reversible elevator motor, it is more than likely that it will be necessary to increase their facilities in order to keep up with their orders. The reversible elevator motor, manufactured by this company, having carbon brushes and running directly connected to elevator mechanism, using no rheostat, is attracting wide and favorable attention from both the makers and users of elevators. Not until a recent visit to Erie by one of our staff did The Electrical Engineer adequately appreciate the size of the business done by the Keystone Electric Works, a business which will be partially indicated by the following list of motors ordered and shipped since Jan. 1, Manager Leech and Electrician Sturgeon are proud of this record, as they may well be:

Marshall Bros., Pittsburgh, 5 h. p. reversible; C. S. Knowles, Boston, Mass., 10 h. p. reversible; John J. O'Brien, Erie, Pa., 3 h. p. shunt for printing office; Erie Electric Motor Co., Erie, Pa., 5 h. p. motor 500 volt for running shops; Jamestown Electric Light & Power Co., Jamestown, N. Y., 2 h. p., for shirt factory; F. W. Brody, N. Y. City, 5 h. p. reversible, elevator; F. P. Jones & Co., Buffalo, N. Y. 3 h. p. shunt, ¼ h. p. reversible, 2 h. p. shunt, for fans, 2 h. p. compound; E. A. Sarran, Cincinnati O., ½ h. p. compound, ¼ h. p. reversible, ¼ h. p. compound, fan; Peninsular Electric Co.. Grand Rapids, Mich., ¼ h. p. reversible; Marcus Ruthenburg, New Albany, Ind., 1 h. p. reversible; Graves Elevator Co., Rochester, N. Y., 10 h. p. reversible, elevator; Marple Engineering Co., Detroit, 5 h. p. reversible; E. J. Reblet, Erie, Pa., 5 h. p. reversible, elevator; McKinnon Iron Works, Ashtabula Harbor, O., 50 light dynamo; Despatch Publishing Co., Erie, Pa., 7½ h. p. shunt for printing; S. B. Harnon, Williamsport, Pa., 1 h. p. compound motor for fans; Hunt & Connell, Scranton, Pa., 1 h. p. compound motor for fans; George Leonhart, Warren, Pa., 1 h. p. shunt motor, fans; Albert Will, Rochester, N. Y., 3 h. p. shunt motor; J. F. Gebhardt, New Albany, Ind,, ¼ h. p. motor, fans; Harris Bros., Jamestown, N. Y., 2 h. p. shunt motor; Jamestown Street Railway Co., Jamestown, N. Y., 10 h. p. shunt motor; C. J. Frank & Co., Cincinnati, O., 3 h. p reversible, elevator, ½ h. p. compound for coffee mill; H. M. Seitzinger, Wilkesbarre, Pa., ¼ h. p. compound, fans; H. J. Reedy Elevator Co., Cincinnati, for Anderson, Ind., 7½ h. p. reversible elevator; Bigelow Electric Supply Co., Lincoln, Neb., one 5 h. p., one 3 h. p., one 2 h. p., one 1 h. p., one ½ h. p. and one ¼ h. p.; Jamestown Electric Light Co., New York, ¼ h. p., ½ h. p., 1 h. p., 2 h. p.; Dr. F. H. Able, Erie Pa., ¼ h. p. for dental work.

AMERICAN DISTRICT STEAM CO.

The American District Steam Co., of Lockport, N. Y., report an increased and increasing correspondence on the subject of the use of exhaust steam from central stations since The Electrical Engineer's recent articles upon that subject. It is becoming obvious to a great many electric lighting and power stations that heat units are being thrown away in exhaust steam during the cool and cold weather which would have a ready and profitable market were a satisfactory system adopted for the use of exhaust steam for heating purposes in the vicinity of stations. The system of the American District Steam Co. has already made a paying success out of more than one central station that has hitherto been unprofitable in lighting and power alone. Mr. I. H. Babcock, treasurer of the American District Steam Co., of Lockport, N. Y., is only too glad to keep up with his growing correspondence on this subject, and believes he sees a way to be a benefactor to the electric lighting and power industry in general.

JONES BROS. & CO.

One of the most notable features of the World's Fair, in Chicago next year, will be a complete model of the entire plant of the H. C. Frick Coke Company, of Scottdale, Pa. This company employs about forty million dollars capital in its business, and is the largest of the kind in the world.

The contract has been let to the Jones Bros. Company, of Cincinnati, Ohio, who are experts in the making of models. The estimated cost of this model is between three and four thousand dollars.

The plant will occupy a space about 20 x 50 feet made on a scale of one-twentieth of an inch to the foot, and will be an exact fac-simile of the original, including boilers, engines, piping, elevated tracks, cupolas, cars and all other machinery and will be in operation. The motive power, however, will be electricity.

NEW YORK NOTES.

The Onandaga Electrical Co., of Syracuse, N. Y., have just purchased five Wood 80-light arc machines, making a total of 400 arc lights, together with 4,500 Slattery alternating and 2,000 Edison three-wire incandescents. They will install four 325 h. p. McIntosh & Seymour tandem compound engines, and four 125 h. p. Wood street railway generators. The company will supply power to the People's Street Railway Co., and will install seven boilers of the Phœnix Iron Works, of Syracuse, of 150 h. p. each. The officers of the company are as follows: W. B. Kirk, president; J. E. Palmer, secretary, (president of the People's Street Railway Co.) and Messrs. Kirk, Palmer, Belden, Myers, Barnes, P. B. McClellan, John McLennon, W. A. Andrews and R. T. McDonald, trustees. The electrical equipment of the plant was ordered through Mr. W. J. Morrison, New York State agent of the Ft. Wayne Electric Co.

Mr. Frank R. Chinnock, one of the most active of the electrical men in this part of the country, and for many years a highly successful representative of the Edison interests, has now carried his energies and aggressive personality into another field. He has become the agent of the Ball Engine Co., of Erie, Pa., and will have full charge of their New York work, etc., with headquarters at 18 Cortlandt street. It is rarely that so well-known a man and so popular an engineering specialty are thus brought together, and the best results may be looked for. Mr. Chinnock's work of late years has given him a thorough insight into the engine and steam business, and he has the further advantage of knowing the needs of the electric light and power industry in a very special manner.

The Interior Conduit and Insulation Co. have issued a superb catalogue, No. 7, of their various excellent productions and specialties. It has all the familiar artistic taste and finish of publications from the Bartlett Press, and is, moreover, admirably arranged. The text is also judicious and helpful. The growth of the business of the company is shown by the fact that this catalogue is in large quarto form and fills 46 pages. It has an ornamental cover in tints of blue.

Mr. Ralph A. Schoenberg, with The E. S. Greeley & Co, 5 and 7 Dey street, has just returned from a Western trip, during which he has established agencies for his "Pneumatic annunciator reset," with such well known concerns as the Central Electric Co., of Chicago; the Electrical Supply Co.; Detroit Electrical Works, Standard Electric Co., of Cincinnati, and Cleveland Mfg. Co., of Cleveland, O.

Mr. Albert E. Davis, manager of the advertising department of *Electric Power*, has resigned his position. He will now have control of the advertising of the Dr. Bury Medical Co. and the Covert Manufacturing Co., both of West Troy, N. Y., where he will hereafter have his headquarters.

The Brush Electric Co. have removed their Eastern offices from 115 Broadway, to the Edison Building, 42 and 44 Broad street, Rooms 1, 2 and 3, fifth floor.

Curtis & Dean, the agents of the Thomson-Houston Electric Co., have removed from 115 Broadway to 38 and 40 New street.

The Storage Battery Supply Co. have removed to the northeast corner of Twenty-third street and First avenue.

The New York Insulated Wire Company, of 13–17 Cortlandt street, have issued a very neat and comprehensive illustrated pamphlet devoted to their "Vulca" duct. It gives a variety of details as to those tubes for interior wiring, with engravings, prices, etc., and has also an excellent section on electric light wiring installations and the features of safety and permanence that have to be taken into account.

NEW ENGLAND NOTES.

The Electric Gas Lighting Company, of Boston, have just issued to the electrical trade, a circular calling attention to the fact that an Indiana house has recently put on the market a new battery which they call the "Hercules" and which they claim is identical with the Samson with "certain improvements." The circular denounces in no measured terms the action of this company, which they claim is wholly piratical, and then goes on to give the results of two sets of comparative tests of the Samson and the new Hercules, one made by Prof. Dolbear, of Tuffts College, and the other by Prof. C. F. Brackett, of the Department of Electrical Engineering at the College of New Jersey, Princeton, N. J. These tests have evidently been made with the utmost care. Prof. Dolbear in concluding his report says: "From all this I conclude that for sustained service, recovery after service, and electrical output, the Samson cell is superior to the Hercules; indeed, I know of no ammonium chloride cell that approaches the Samson in desirable qualities." Prof. Brackett winds up his report with the following words: "It appears from the foregoing details that the 'Samson' cell is in every way greatly superior to the 'Hercules.' It has much less internal resistance, a much greater sustaining power as respects voltage, consequently it affords a much greater current, and this through a very much longer time; and lastly, its power of recovery is very much greater. Indeed, I know of no open-circuit battery cell which can compare with it." All interested in battery work should procure a copy of their circular, as they will find much therein that is interesting and instructive.

The Bradbury-Stone Storage Battery Company, of Lowell, Mass., have just issued a very comprehensive and interesting catalogue relating to storage batteries, and their varied uses for electric light and power. In this catalogue they make strong claims for its practicability in street railway work, and give some interesting examples of its success in this line. Its adaptability is also clearly set forth for use in mill tramway service, mining service, propulsion of vehicles, propulsion of launches, elevators, cash carriers, dental lathes and drills, church organs, phonographs, fans, coffee mills, deposition of metals, various kinds of electric lighting, and a host of other services too many to enumerate. The book is well illustrated and shows the battery in various forms, and contains useful tables for calculating the size of battery required. There are also a number of illustrations of special switches and various devices used in conjunction with the storage battery, and the book concludes with a large number of the warmest kind of testimonials from many who have used the battery with the most gratifying success.

The Electric Heat Alarm Company, of Boston, are in receipt of two very warm testimonials regarding the working of their heat alarm apparatus, from the Paine Furniture Company, and E. B. Stillings & Co., both of Boston. These installations have been working now for some weeks, have done all that was claimed for them, and have already warned the attendant engineers of bearings which were growing too warm for safe working. All engineers should investigate this system closely, as it is easily and cheaply applied, and affords a protection which it is difficult otherwise to get.

The Fitchburg Engine Company, of Fitchburg, Mass., have moved into their new and capacious factory on the outskirts of Fitchburg, and have now got much more ample room for the speedy execution of their numerous orders. They have erected a handsome two-story brick building, 100 feet long by 75 feet wide, and have fitted it up with the most modern machinery. Overhead travelling cranes traverse the entire shop, and shipments are made direct on to cars on a side track of the Fitchburg Railway, specially run in for the purpose.

Thf Massachusetts Electrical Engineering Company, of Boston, have been appointed by the State House Commissioners to take entire charge of the installation of the electric light plant for the new Boston State House extension, and are at present preparing plans and specifications for this work. No contracts have yet been awarded, but they will be given out as soon as the plans are completed.

Mr. Hollis French has become connected with the Massachusetts Electrical Engineering Company, as one of their regular staff of electrical engineers. Mr. French, who is well known in electrical circles, has been abroad for the past year on electrical business, and brings with him a wide experience in all kinds of electrical engineering work, gathered in this country and abroad.

The Corliss Steam Engine Company, of Providence, R. I., have just completed the installation of another, the third, engine in the central station of the Worcester Electric Light Company, of Worcester, Mass. This engine will be of their regular Corliss type, with cylinders 22 inches and 42 inches by 48 inch stroke. The fly-wheel is 22 feet in diameter, 62 feet face and weighs 55,000 pounds. The engine at 79 revolutions, will develop about 600 h. p., and has been built extra strong all through, being a magnificent specimen of the Corliss type of engine for electrical purposes.

The Porter and Leavitt Manufacturing Company, of Providence, R. I., have now got comfortably settled in their new quarters on Mitchell street, and have now ample capacity for transacting their largely increasing business in fan motors. The Porter and Leavitt motor has made quite a reputation for itself in the past year, and business prospects for the coming year are extremely good, a good reliable small motor, capable of being run from batteries, being highly appreciated.

WESTERN NOTES.

The Blake Pump.—No single piece of machinery in an electric light or power plant is more sensitive than the boiler feeder. It is therefore of high importance that the pumps used for this purpose be of the highest excellence. The Pond Engineering Co., report great success with their Blake pump for this service. Recent shipments going to Albia, Ia., Electric Light Co.; Holden, Mo., Electric Light Co.; Warrenton, Mo., Electric Light Co. Janesville, Wis., Electric Street Railway Co.; Camden, Ark., Electric Light and Power Co., two; and Cicero and Proviso Street Railway, Chicago; Vincennes, Ind., Electric Light & Power Co., two.

The Central Electric Company have just secured the Western agency for Schoenberg's pneumatic annunciator reset. This is a very valuable and unique device for replacing the drops in annunciators, which is done by simply pressing a rubber bulb which drives air into a rubber bulb at the other end which raises the drop as it expands. It has been illustrated in **The Electrical Engineer**.

The Electric Appliance Company report that spring business is beginning to make itself felt. The sales of Paranite wire are increasing in a manner that gives evidence, they say, that it has not failed to meet the highest requirements. The demand for "Canvas Jacket" wire also indicates that the general tendency is for a higher grade of line construction.

Mr. Gilbert G. McDuff, well known as a newspaper man in electrical circles in the West, has accepted a position with *The Electrical World*, and will represent that concern on electrical directory work throughout the country.

The Railway Equipment Co. report business as very brisk, and already have several large contracts for line material and equipment for new street railway plants and extensions.

Mr. P. C. Burns, of the Peru Porcelain Works, was in Chicago visiting last week and has taken his usual orders for porcelain specialties they manufacture.

Mr. W. L. Moase, of the Detroit Electrical Works, was in Chicago last week. He reports an excellent trade throughout the West and Northwest.

Charles E. Wilson has accepted a position as salesman with the Railway Equipment Co.

PHILADELPHIA NOTES.

Partrick & Carter Co. have discontinued their Canadian agency, and will hereafter supply the trade direct from their Philadelphia headquarters, 125 South Second street. They will send catalogues and special trade discount sheets to any Canadian or other address upon application.

Mr. Chas. E. White, who for the past two years has acted as superintendent of the Pottstown, Pa., Electric Light Co., has resigned his position there to occupy a similar one with the Front Street Merchants' Electric Light Co. of this city.

Prof. L. F. Rondinella, M. E., mechanical, electrical and civil engineer, has opened new offices at 705 Chestnut street, Philadelphia. He will continue his work, however, at the Central Manual Training School.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.
VOL. XIII. MAY 11, 1892. No. 210.

LONG-DISTANCE TELEPHONY.—II.

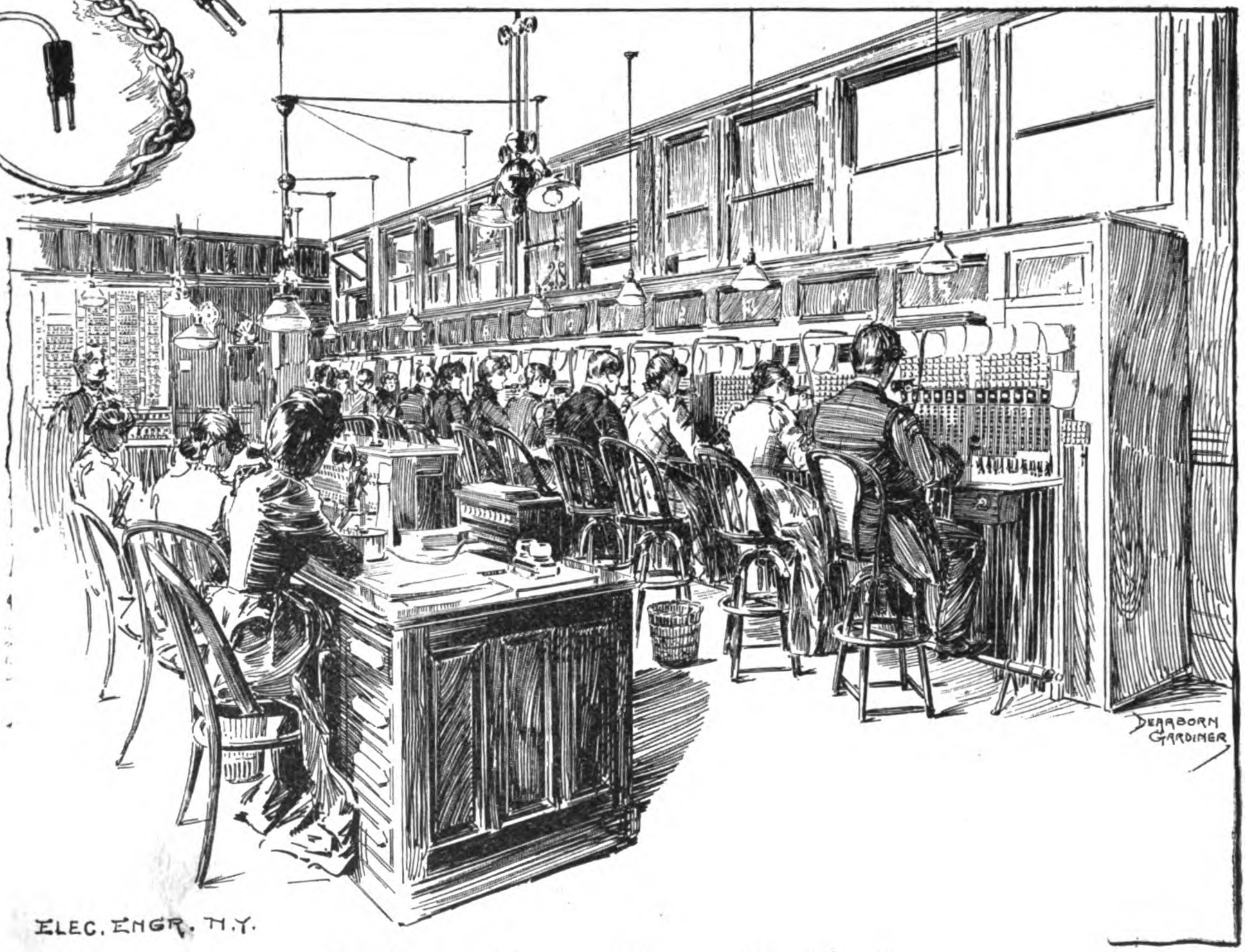
BY

Herbert Laws Webb

IX.

O FAR we have chiefly discussed the part that the line plays in the long-distance telephone system and it has been made plain how important a part that is, but although it is true that a great deal of attention and study has been devoted to the line question, the other elements of the circuit, such as transmitters, receivers, annunciator drops, switching apparatus, bells, repeating coils, lightning arresters and all the various items of office and terminal equipment have by no means been neglected. Both in the laboratory of the American Bell Telephone Company, at Boston, and in the engineer's department of the American Telephone and Telegraph Company, at New York, skilled experts are constantly at work devising new instruments and working out modifications and improvements on old ones. Every portion of every instrument undergoes expert inspection and criticism and the dimensions and style of every screw, washer and binding post are set forth in the specifications drawn up for the manufacture of all the various pieces of apparatus that are used.

The instrument equipment of a long-distance line differs materially in various particulars from that of a local telephone line. A more powerful transmitter—one capable of a greater range of variation of resistance and of employing a stronger battery current—was the first desideratum, as the high resistance in such long lines required all that could be obtained in the way of what we may call sound energy to allow for loss in transmission. The ordinary type of Bell receiver is such a delicate instrument that it leaves no room for further refinement in this direction; the improvements that have been made in it have been mainly mechanical rather than electrical, and it remains what it was when first given to the world—the most wonderful and the most delicate instrument known to electrical science.



LONG-DISTANCE TELEPHONE EXCHANGE, NEW YORK CITY.

The transmitter adopted by the Long-Distance Company is a modification of the Hunning instrument, employing granular carbon as the medium for varying the resistance in the battery circuit. The original long-distance transmitter was devised at the laboratory of the American

Bell Telephone Company; its design is totally different from the original Hunning instrument, the only similarity being in the use of granulated carbon which Hunning adopted instead of two solid electrodes in light contact with each other. It is an extremely compact instrument, needs no adjustment after once set up (providing that it is not ill-treated) and has given excellent service during the years that it has been in use. It is now being replaced by a later form of instrument constructed on the same principles but after a different pattern; this new transmitter, called the "solid back," even excels the familiar "long-distance" as an efficient transformer of sound waves into electric undulations.

The long-distance transmitter consists of a little circular metal chamber which is generally attached to a hinged arm mounted on the iron box that contains the induction coil. To the neck at the lower part of the metallic chamber is fixed a hard-rubber mouthpiece which directs the voice to the platinum diaphragm that rests on an insulating ring placed at the bottom of the chamber. This platinum diaphragm is clamped down by a brass ring; and a binding post, insulated from the chamber, which passes through it near the edge, affords a connection for one side of the battery circuit. Above the brass ring is placed a collar of boxwood, which forms a small insulated receptacle for the granular carbon. A brass electrode, shaped like a pulley wheel and having radial holes, fits loosely into the insulated chamber; the upper flange of this little pulley rests on the rim of the metal chamber, making good contact with it, and the lower surface, which is slightly concave, comes within about a sixteenth of an inch of the platinum foil diaphragm. The granulated carbon, which is so finely divided as to be a fine flaky powder, occupies the spaces between the electrode and the diaphragm and between the grooved periphery of the electrode and the insulating collar; the radial holes in the electrode serve the purpose of exposing additional surface to the granulated carbon. As the electrode is in close contact with the transmitter chamber, the primary circuit is completed through the chamber and the supporting arm to the thick winding of the induction coil. This transmitter has been the result of a vast deal of study and experimenting, and while being extremely compact it is very little liable to get out of order or to fail from any cause except bad usage. The platinum foil diaphragm, being the most vulnerable portion of the instrument, is protected from the attacks of inquisitive lead pencils or other implements of unskilled labor by the insertion of a couple of wires across the narrow part of the mouthpiece—a very necessary precaution.

X.

The latest type of long-distance transmitter is called the "solid back" because the chamber containing the electrode and diaphragm is mounted vertically in front of a solid metal backing in place of the horizontal chamber and adjustable arm of the instrument just described. In the "solid back" the brass electrode is done away with and an extremely small metal chamber is employed. To the diaphragm is attached a small button of hard close-grained carbon prepared by a special process for this purpose. This granular carbon button serves as one electrode and presses lightly against a thin layer of granulated carbon, which it thus holds in position in the little metal chamber that forms the second electrode. This arrangement is compactness itself and the mechanical design of the instrument is very good. No adjustment whatever is required when once the transmitter has been put together and properly tested. The electrical efficiency, as has already been stated, is even greater than that of the original long-distance transmitter.

Both these transmitters are worked with a primary battery current having an electromotive force of about six volts. The electromotive force should not fall below this figure and the internal resistance of the battery should be as low as possible, to give the best results. The resistance of the primary winding of the induction coil used with the long-distance transmitters is .4 ohm and as the lowest resistance of the transmitter itself is only a few ohms the total resistance in the primary circuit is very low; a battery that will not polarize quickly is required for the work, especially as the instruments are often used for long periods without a rest. The Fuller bichromate battery has been found to give the best results, and three cells are supplied with a long-distance outfit. This amount of battery gives the requisite electromotive force of six volts, and when in good condition the cells have a fairly low internal resistance. The current taken by the long-distance transmitter when the battery is in good condition ranges from .6 to .7 of an ampere; if the current were to exceed the higher figure by very much the transmitter would become too hot and its speaking efficiency would be lowered. The resistance of the secondary winding of the induction coil is 14 ohms; the coil is wound over an extra long core and is enclosed in an iron box to which the transmitter arm is attached.

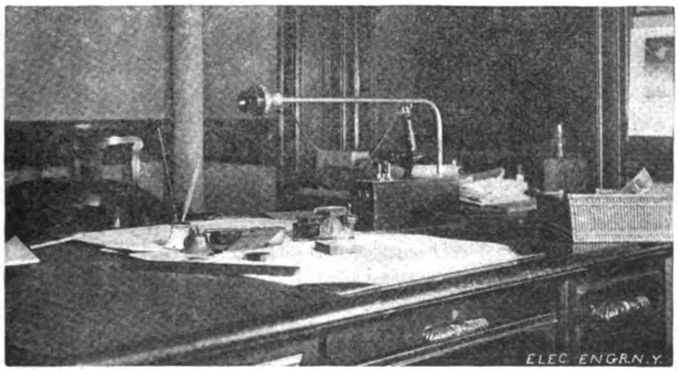
XI.

The long-distance instruments are most familiar to the general public in the form of cabinet sets, an extremely sightly form of telephone instrument. The transmitter arm is mounted on a neat little desk, which is provided below with a small closet for the batteries. In an enclosed compartment at the back of the desk are fitted the induction coil, magneto bell and generator, automatic switch and lightning arresters. Where space is an important consideration, wall sets are supplied, the various parts of the equipment being mounted on a more or less ornamental backboard, which is fixed to the wall in the same manner as an ordinary Blake set. The long-distance transmitters, being of compact form and ornamental finish, are well adapted for combination with neat metal stands for desk use. Of these desk instruments quite a variety of patterns has been designed by the telephone companies, principally for use in their own offices, where telephone communication between the different departments and out-of-town offices is in constant requisition. With these desk instruments it is of course necessary to provide special switching and bell equipments and a separate place for the battery, as the desk stand only carries the transmitter and receiver.

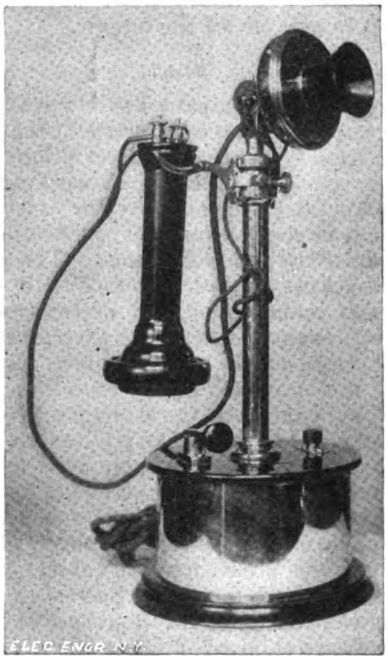
The utmost care is always taken in keeping the long-distance instruments up to the top notch of efficiency. Practically the only part of the instrument equipment that really requires taking care of and attention for maintenance is the battery, as all the working parts are of such good material and so carefully put together and protected that it is very seldom that anything goes wrong with them. It is highly necessary, however, that the battery shall be maintained in the very best order as a very slight falling off in its strength makes a considerable difference in the efficiency of the transmitter, much as a slight decrease of pressure in an incandescent circuit causes an altogether disproportionate loss of illuminating power in the lamps. A very simple and effective test of the strength of the transmitter was accidentally hit upon some time ago by the general superintendent and the engineer of the Long-Distance Company during the course of some experiments that they were making on a line. In order to muffle the sounds coming over one circuit, on which one of the experimenters was talking in a loud tone, to obtain quiet for listening for induction on the other, the turbulent receiver was held against the mouthpiece of the transmitter of its own circuit. The receiver immediately gave out a loud musical note of high pitch, which was sustained as long as the receiver was held in front of the transmitter. The explanation of the phenomenon is simple enough. The diaphragm of the receiver being in a state of vibration acted through the column of air separating the two, on the diaphragm of the transmitter, which in turn reacted through the induction coil on the receiver, the impulses following each other with sufficient rapidity to form a musical note. It was found afterward that the note could be produced by giving the receiver a slight tap against the transmitter mouthpiece, or by calling or whistling into them when held together so as to start the vibration. This automatic performance of the telephone was experimented with to a considerable extent just after the discovery was made, and at times a perfect chorus of shrill shrieks could be heard on the second floor of the Telephone Building, which is chiefly occupied by the technical departments of the Metropolitan and Long-Distance companies. A favorite diversion with the experimenters was to call somebody up in another office and ask him to listen for a moment, then to place receiver and transmitter together and start the note, which of course was produced with equal distinctness in the distant receiver. As a result of these experiments it was found that the note could only be obtained when the battery was in very good condition; if the battery was at all run down all efforts to start the note would prove unavailing. Consequently the effect was applied to a useful purpose and has since served as an acoustic battery test; if the telephone will sing it is taken as a sign that the battery is up to the mark, whereas silence means just the opposite. It has been found, however, that this battery test is not so reliable as was first thought, because a decided change is produced in the note when the connections either of the battery or of the receiver are reversed. Generally, if the battery is strong, the telephone will sing either way, but a reversal of the battery or of the terminals of the receiver will raise or lower the pitch of the note. The consequence is that on occasions the battery may be just strong enough to make the telephone sing when the connections are in one direction, but if the connections are reversed the telephone will remain silent in spite of all efforts to start the note. As a battery test, then, the note can only be taken as an approximate indication of the state of affairs.

XII.

In the operation of long-distance telephone lines it was soon found that the ordinary methods of connecting instruments and switchboard apparatus in series would have to be modified and that the two sides of the metallic circuit must be made as much alike as possible. A great many experiments were tried before the fundamental result was arrived at that in order to eliminate all disturbances and secure a perfectly quiet line it was necessary that the two sides of the circuit should balance exactly in all respects—copper and insulation resistance and inductive capacity. If there were sufficient variation between the resistance or capacity of the two sides of the circuit to seriously upset the balance, inductive disturbances would be introduced, and if the insulation of one of the wires were good and that of the other very low, a similar effect would result. So easily may the balance be upset that a long line, which under ordinary circumstances is perfectly quiet, may be rendered extremely noisy, so much so that it is almost impossible to talk over it, by the addition of a very slight resistance or capacity to either side of the circuit. In the case of the London-Paris telephone line it has been stated that by connecting a condenser of only a fraction of a microfarad capacity to one side of the circuit the balance was entirely destroyed, although the line is normally absolutely inductionless. The refined methods of line construction previously described provide for the line itself being properly balanced, and the balance is preserved at all points where instruments are connected to the line by bridging them across instead of looping them in direct according to the old system. The annunciator drops on the switchboards are bridged, and where several instruments are connected on one line they are all connected in bridge; the operator's circuit at the exchange is also joined in bridge so that all the apparatus on a long-distance telephone line is connected in multiple arc, just as in an incandescent electric light system. In this manner a practically perfectly balanced line can be secured, but in order to secure efficient working on this plan it was necessary to considerably modify the types of apparatus previously in use on the looping-in system.



LONG-DISTANCE TELEPHONE SET FOR DOUBLE DESKS.



LONG-DISTANCE TELEPHONE SET.—UPRIGHT PATTERN.

In order to bridge instruments across the line at different points it is necessary, of course, that the distribution of the current should be borne in mind and that the bridges should be of sufficiently high resistance not to short-circuit the line at any point and thereby prevent good transmission between the stations beyond. The peculiarities of the telephonic current and of the alternating current used for ringing purposes have to be taken into account in designing apparatus to be connected in multiple arc, and the phenomenon of retardation comes in very usefully in this respect. By constructing coils of such dimensions as to take proper advantage of the effect of retardation, annunciator drops or bell magnets may be permanently bridged across the circuit without in the least impairing the efficiency of transmission, even on very long lines. The coils are wound with very fine wire to an extremely high resistance, and the high coefficient of self induction of the coils results in enormous impedance to alternating currents so that the bridge absorbs but a very minute proportion of the speaking current. The automatic bridging magneto bell designed by Mr. J. J. Carty operates on this principle. The ringer magnets are permanently connected in bridge across the line, and with a line containing as many as twenty or thirty stations the transmission between any two of the stations is practically as good as if no bells at all were in circuit. The experiment has been tried of connecting a large number of the bridging bells in circuit with a long-distance line between New York and Boston, and no difference could be noticed in the transmission when the bells were cut in and out of the circuit.

XIII.

The Long-Distance Company has always devoted great attention to the perfection of all parts of the equipment of its lines, and from the foregoing description of the exigencies of long-distance metallic circuit-working it is obvious that there is abundant opportunity for scientific research and experiment in connection with the complicated apparatus that modern telephony demands. The improvements that have been made in the various details of the equipment are almost innumerable, and experience and experiment constantly suggest others. A great deal of study has been concentrated on the central office question, which, while it does not approach in the magnitude of its problems that which confronts the managers of local systems in large cities, still has many fine points that are rendered none the less easy because the same care and refinement must be maintained in the mazes of switchboards and office connections jammed into a small space as are observed on poles and cross-arms, where there is plenty of elbow-room, and in the luxurious dimensions of cabinet sets, where no two wires are allowed to cross. Special metallic circuit switchboards were designed for the long-distance operating rooms. These switchboards are not wired on the multiple system, as the nature of the connections and the number of circuits in use do not render the use of multiple switchboards advantageous. The circuits in the switchboard, instead of being each connected to one spring jack, are separated, and the two sides of a metallic circuit are connected to two separate spring jacks. This arrangement was made in order to avoid all risk of leakage and other troubles in the spring jacks. A special twin plug, made by placing two ordinary round plugs in a single handle, is used to make contact with the two spring jacks, which are placed close together, but thoroughly insulated from each other, in the switchboard. The annunciator drops used on these switchboards are known as the "tubular" drops, and were designed for long-distance working; they have high retardation and are connected in bridge across the circuit. Special metallic circuit ringing keys are provided, by means of which the operators can throw the generator current on to any line by merely pressing two small buttons; the generators are kept running constantly by means of an electric motor and leads from the generators are run through the switchboard and tapped to the ringing keys. The listening keys by which the operator's outfit of transmitter and receiver is bridged across the line are of the cam lever pattern, extremely easy to manipulate. The working parts of the ringing and listening keys are protected from dust beneath the shelf of the switchboard, only the buttons and cams showing above. The keys make contact by pressing down thick wedges of hard rubber between two sets of metal springs. Normally the wedge is up and the springs are insulated from each other; when the wedge is pressed down the springs are pushed together and make contact. The contacts are always kept clean, as the springs are so designed that there is a slight rubbing action when they are brought together and separated.

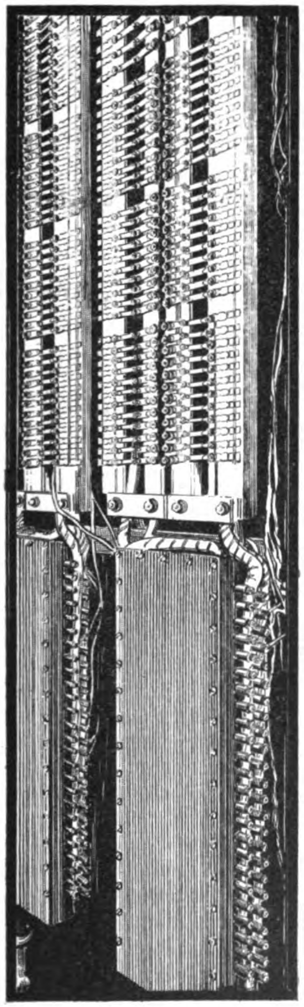
The protection of their lines and apparatus from damage by lightning and strong currents from other electrical systems is a question to which telephone engineers have devoted unceasing study. There are various points in an extensive telephone plant that require protection, and different measures have to be adopted in different situations, thus materially complicating the problem. A long telephone line is generally made up of overhead wire with occasional links of submarine cable at river crossings and a few miles of underground cable at the city terminals of the line. The submarine cables must be carefully protected as they are expensive and take time to replace or repair if damaged; the underground cables need efficient protection for the same reasons. The delicate apparatus at the subscribers' stations and at the exchange calls for the most jealous protection because a "sneak current" of very moderate strength will soon store up sufficient heat in the fine windings of bell magnets and annunciator coils to burn them out. At places which are not readily accessible, such as cable houses at river crossings in the country and cable towers on poles at the outskirts of towns, the protecting apparatus must not be so delicate as to interrupt the circuit unnecessarily, but must be gauged to act just at the point when the portion of the circuit which it guards is in danger, and no sooner. For the proper protection of insulated metallic circuits some device is required which will act when the line is charged to a high potential by accidental contact with a high tension circuit. It might easily happen that a wire belonging to an electric light or power line operated at high voltage should come in contact with a well-insulated metallic circuit telephone line, in which case the telephone circuit would become charged to the potential of the foreign wire and there would be no flow of current to operate a fuse or other style of arrester dependent on current for its proper action. It is necessary then to provide for this possible condition, which, of course, might render the circuit dangerous in several senses. Lastly, arresters or protectors containing electromagnets to be inserted in the line are not looked on with favor by telephone men owing to the retardation introduced by the electromagnets, which naturally militates against good transmission. From all this it will be seen that the proper protection of metallic circuit telephone lines and apparatus from damage by foreign currents is no very simple undertaking.

XIV.

The telephone companies by dint of careful experimenting have worked out a thorough system of protection for all points open to attack. At submarine cable crossings a special form of brass plate air space lighting arrester is inserted between the line wire and the cable. A spiral coil of copper wire is also placed in circuit; the impedance offered by the coil to a sudden rush of current induces the discharge to jump the air space to ground rather than to enter the cable. This arrester is also provided with a fuse which melts and opens the circuit when the current flowing reaches ten amperes; this fuse protects the cable from damage by a steady current which might be sent through the overhead wire through accidental contact with an electric light or power line. At the junction between an overhead line and an underground cable a fuse which blows at eight amperes is inserted in the circuit for the protection of the cable conductors. It was formerly the practice to place more delicate fuses, designed to blow out at, say, two or three amperes, at the outer terminals of underground cables, but so much delay was caused by the fuses blowing out and opening the line on the slightest pretext that it was decided to let the cable take care of anything up to eight amperes, which it can safely do, and to look out for small currents at the office end, where burnt-out arresters can be more easily and quickly replaced than they can be on cable poles in the suburbs. At the exchange terminals of the underground cables a special form of strong current and lightning arrester, designed at the laboratory of the American Bell Telephone Company, is connected to every conductor. This arrester is provided with an air space cut-out which interrupts the circuit and grounds the line when the circuit becomes charged to a potential of 300 volts. The line being grounded, current will flow, and the fuse at the outer terminal will open the line and prevent any damage to the cable conductors. A "sneak" current arrester completes the protection afforded to the instruments; this consists of a small coil of fine wire wound on a little bobbin through which a metal pin passes but is prevented from passing clear through by a drop of fusible metal. A current of .28 ampere circulating in this coil for thirty seconds generates heat enough to melt the fusible metal, releasing the metal pin and the spring which it holds down. This spring grounds the line, and all the apparatus beyond the arrester is cut out of circuit. Subscribers' instruments are provided with lightning and strong current arresters of the same pattern as those used in the central office. No current of sufficient strength to injure the instruments can possibly pass these delicate arresters.

XV.

Long-distance operating-rooms are established in all the principal cities to which the system extends; they are generally in intimate connection with the principal local exchange, as of course many patrons of the long-distance service are among the subscribers to the local service. The New York office is in the Telephone Building at 18 Cortlandt street, and is immediately below the largest exchange of the Metropolitan Telephone and Telegraph Company. A description of this office will serve as a typical illustration of the manner in which the long-distance service is conducted. The wires are brought into the exchange through underground cables, which reach the overhead lines at various points by means of the underground system of the Metropolitan Company. These cables are headed up immediately outside the operating-room and connected to a small cross-connecting board, at the opposite side of which are terminated the wires from the switchboard. The cross-connecting board is an iron framework divided into vertical and horizontal runs through which the wires are led in definite courses. The line wires being all soldered to rows of metal plates mounted on hard-rubber strips at one side of the board, and the switchboard circuits being terminated in the same manner at the other, any pair of line wires can be connected to any switchboard circuit by running a pair of wires through the cross-connecting board. This arrangement forms a very convenient method of making new connections or effecting changes in existing ones, as all the work required is done with a single pair of wires run between two fixed points. Between the cross-connecting board and the switchboard proper all the wires pass through a test board, where every wire is connected to a spring jack; of these test boards there are two, one for wires leading east from New York and the other for wires going west.



Cable Terminals on Cross-Connecting Board.

The test boards are provided with Morse keys and relays, Wheatstone bridge and galvanometer for testing the lines. Every morning at an early hour a test is made on every line by the chief operator, who enters the results in his log book. When the lines are all in good condition the testing does not occupy very long, and, as we have already seen, it frequently happens that no trouble is found on any of the lines. When a trouble is discovered, its locality is traced down very quickly; different stations are cut in on the defective circuit until the trouble is placed between two of them, and then, if the lines are crossed, copper resistance measurement will give the location of the cross with very fair accuracy. Regular testing stations are established at fixed intervals along all the main lines and competent linemen are in readiness at various points to start out to remove troubles and make repairs at a moment's notice. So systematically is the daily testing of the lines done and so quickly are ordinary troubles traced out and attended to that it is very seldom that any line remains out of service after ten o'clock in the morning, the daily tests being made between the hours of seven and eight a. m. Every trouble discovered is noted in the log book of the chief operator together with all details as to its nature, location, the name of the lineman sent to repair it, the time he started and where from, and so on. The next entry will be the time the circuit was made O. K. again, together with any further remarks relating to the report made by the lineman. All these records are carefully preserved and tabulated, and if it is found that troubles frequently occur in a certain locality or on a certain circuit a definite cause is suspected and a strict inquiry is made in order to strike, if possible, at the root of the evil. In this manner much curious and useful information is obtained as to the conditions which affect the working of overhead electric wires in various parts of the country. Of course, during severe storms the wires and poles must necessarily suffer to some extent and there are occasional extraordinary combinations of atmospheric disturbance which the weather students account for by wonderful stories about a cold wave from the northwest meeting a warm wave from the southwest and the two mixing themselves up with a hurricane from Tennessee and an Atlantic gale charged with vapor from the Gulf Stream; against such phenomenal meteorological vagaries as these, which are commonly called blizzards, the stoutest construction cannot always hold out at every point. But when accidents happen the long-distance company is not content to rebuild merely and be done with it; a detailed investigation is made and the lesson is profited by to the fullest extent. If the experience suggests improvements they are adopted, and if weak spots are discovered they are carefully avoided in future work, so that a certain amount of valuable information may be extracted even from a destructive blizzard.

Desk Telephone Set.

XVI.

From the test board the lines run to the switchboards where they are connected to twin spring jacks and bridged tubular drops, as previously described. The switchboards are divided up into different sections at which the lines are terminated according to the districts which they reach; for instance, one section contains the lines running to New Haven and Hartford, another those going to Bridgeport, Norwalk and Stamford, another Boston, another Philadelphia, and so on. This arrangement of switchboards is found to suit the nature of the business very well and no substantial departure has been made from it since the operating-room was first equipped—about four years ago.

At the same switchboard a number of local lines are terminated on special drops; these lines are rented by business men and firms in New York, who use the long-distance service to a large extent, many of them requiring connection with certain points for several hours each day. The local lines terminated at this board are those of subscribers the greater proportion of whose business is with the same outside places; the lines are therefore distributed through the switchboard in proximity to the trunk wires with which they most frequently have to be connected. In another part of the operating-room is placed a smaller switchboard, connected by trunk wires to the various sections of the principal board; here a number of local lines are terminated the renters of which require communication with various points in the long-distance system. Their connections are more easily handled through this intermediate switchboard than if the lines were terminated at the main board; the operators who handle these local wires are connected by trunks to every section of the main switchboard and they pass on the connections by these trunks, giving the trunk wire operator the order for the connection required over a calling circuit. At the extreme end of the operating-room is placed a section of the metallic circuit multiple switchboard of the Cortlandt Street Exchange of the Metropolitan Company. Nearly 5,000 lines of New York subscribers terminate at this switchboard and the placing of a complete section in the long-distance operating-room greatly facilitates the work of making connections between local subscribers and long-distance points or subscribers in any of the cities reached by the long-distance system. Trunk wires are run from the local multiple section to the various sections of the long-distance switchboard and two operators are kept constantly busy making long-distance connections for local subscribers. The section of the multiple switchboard is provided with special four-point spring jacks by means of which the circuit running through the rest of the board is cut off when a long-distance connection is put up, thus preventing an operator at any of the other sections from cutting in on the line and obviating the risk of any accidental interference with the conversation. A further improvement is to throw on a special test current in addition to cutting off the multiple switchboard circuit so that the line if tested by the operators at the other sections shall show busy in the long-distance room. Trunk lines run from the long-distance switchboard to the other local exchanges in New York, so that long-distance connections with local subscribers can be made with the minimum number of switchboard connections.

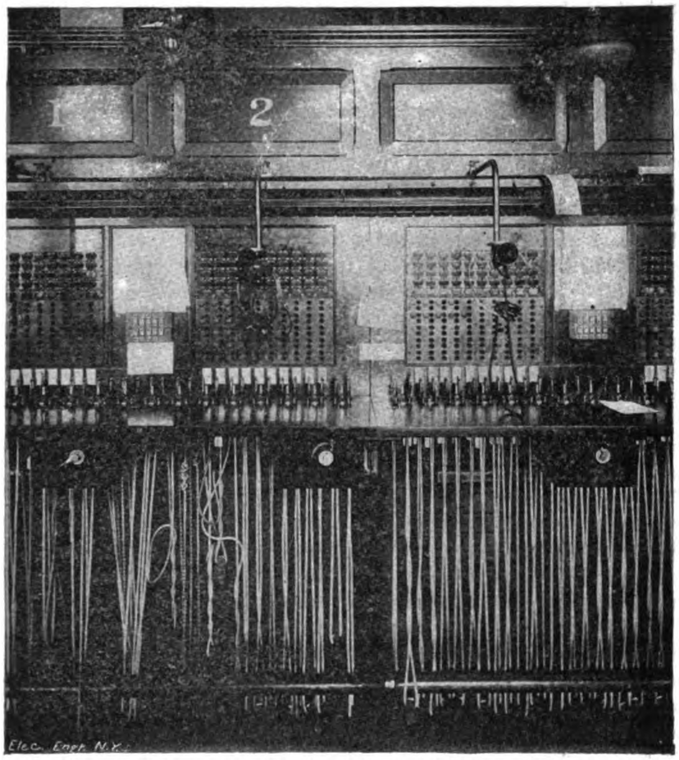
XVII.

The operators are provided with adjustable long-distance transmitters and head receivers of the regular type used in all exchanges. On the shelf below the spring jacks and drops are placed the plugs and cords for putting up connections, the terminals of the trunk lines which join the different sections and switchboards and the operators' listening and ringing keys. Every connection made is entered on a blank at each end of the line; the entry on this blank states the places between which the connection is made, the names of the speakers, the time at which the connection is put up and taken down and the number of the circuit used; the check is signed by the operator and she is responsible for the accuracy of the entries.

The operation of the long-distance service is sufficiently complicated and varied, but the work is so thoroughly systematized and so carefully supervised that very little time is lost in making connections and in taking them down when the line is finished with. A large proportion of the connections are calls for short conversations from local subscribers and from the pay stations established in all parts of New York and other large cities. The principal pay station is that which occupies the first floor of the Telephone Building, at 18 Cortlandt street; it contains six booths, which are in constant requisition all day long. All the pay stations where much business is done are supplied with sound-proof booths, which greatly add to the comfort of a talk over the telephone. Most of the business done by the pay stations and the chance calls of subscribers to the local system is in the form of five-minute conversations, five minutes being the minimum time charged for. In order to work the wires to their best capacity it is obvious that the necessary switching and ringing on the part of the operators must be done very smartly and smoothly, because several minutes, say two or three, may easily be spent in putting each connection through and in restoring everything to its normal condition when the conversation is finished. Although a certain amount of time must obviously be allowed for making the connections called for and for discontinuing them at the end of the specified time, yet it is equally obvious that the time during which the plant and staff are unprofitably engaged must be reduced to the lowest possible fraction of the working day. At first sight one would say that at five minutes for a talk each circuit would accommodate 12 conversations in an hour. But allowing about three minutes for switching and calling at both ends of the line and taking down the connection afterward, we get about seven or eight talks in the hour and find that for about 40 per cent. of the time the plant is earning no money.

By way of reducing this percentage the principal main lines are now worked on the double-track system, all connections being ordered up and down over a special calling circuit. The rapid increase of busines has rendered necessary the adoption of this system, which results in a large saving of time. Between New York and Boston, for instance, a certain number of circuits are set aside for work originating in Boston and a certain number for work originating in New York. One pair of wires between New York and Boston is used exclusively as a calling circuit to transmit orders for putting up and taking down connections. At each office the lines terminate at two sections of the switchboard, one for inward service and the other for outward; the operator at the outward board speaks directly to the operator at the inward board at the distant office over the calling circuit, which terminates at the inward operator's head telephone. The sending operator at New York gets a call from Williams & Robinson for communication with John Brown & Co., of Boston. She plugs them on to a line and calls to the Boston operator "John Brown & Co. on 15 and 16 for Williams & Robinson." The Boston operator plugs John Brown & Co. on to circuit 15 and 16 and the connection is made. When the New York operator gets the clearing-out signal, or when the time is up, she tells the Boston operator to take down 15 and 16 and the line is clear again. The same performance takes place with the other set of lines, the only difference being that Boston does the ordering up and down. This system does away with all the work of ringing up, waiting for clearing-out signals at both ends of the line and other minor causes of delay, and the saving of time and consequent improvement of the service amply compensate for the withdrawal of a circuit from public use to be used exclusively for the regulation of the traffic.

Besides the pay station business and that arising from calls by local subscribers the long-distance system has a great many regular patrons who use the service every day. Others transact so much of their business by telephone that they require the exclusive use of a long-distance line for several hours each day, the time being generally divided up so as to give two or three long talks during the day. Others, again, rent the entire use of a line and maintain communication between their different establishments throughout the day. Besides all this private business, the long-distance service is in high favor with railway corporations and newspapers. For the transmission of orders relating to the operation of railways the telephone has the advantage of being a time saver, as talking is far quicker than telegraphing; another good point that endears it to railway managers is that the long-distance wires remain in working order at times when the telegraph lines are completely paralyzed. The Pennsylvania, New York Central, Old Colony, and Boston and Albany railway companies make extensive use of the telephone for the transaction of their business, and on various occasions have had to rely on it completely for days at a time. The newspapers also have sometimes had to depend exclusively on the long-distance telephone for out-of-town news, as, for instance, after the blizzard of four years ago; having once used it they have been quick to see its adaptability to many of their special needs. For reporting races, baseball and football games, elections and other occurrences in which a lively public interest is taken from the field of operations the telephone is infinitely superior to the telegraph. Some time ago a New York daily paper sent a reporter to Boston to describe a baseball game of special importance. Instead of adopting the usual method of taking notes to be sent by telegraph, a long-distance circuit was arranged for connecting the baseball grounds directly with the head office in New York. The reporter was provided with a telephone outfit and he simply had to describe the game as it went on, his dictation being handed to the compositors as rapidly as it was received. Three minutes after the conclusion of the game a full account of it was set up in type and within an hour or so an "extra" was selling in the streets of New York containing a vivid and detailed description of the match. By proper organization this *fin de siècle* method of reporting distant events can be made to give startling evidence of newspaper enterprise in a variety of different ways, and in the long-distance telephone system the newspapers undoubtedly have a powerful and valuable addition to their means for collecting and transmitting the "latest intelligence."



A Section of the Long-Distance Switchboard.

XVIII.

One of the chief difficulties that the Long-Distance Company met with in introducing its service to the public lay in the repugnance of heads of firms to use the telephone themselves.

It must be borne in mind that the long-distance service is chiefly useful to people having important private communications to make, such as the exchange of quotations between branch houses of bankers' and brokers' firms, consultations between lawyers, the transmission of confidential orders from the head office in town to the factory in the country and a host of other transactions of a special character which would ordinarily require personal interviews or the employment of responsible messengers. In order, then, to bring the advantages of the long-distance telephone system home to those for whom they were intended it was necessary to induce men to use the telephone who had never used it before, but had always left it to the mercy of office boy or clerk. Considerable difficulty was experienced in doing this, as many people on the first occasion of using the telephone persist in saying that they can hear nothing and working themselves into such a nervous state that in a short time they can say nothing either. It is not often taken into account that the telephone, while being the most delicate electrical instrument known, is the only one that the general public actually uses, and the general public, or a considerable proportion of it, is rather slow to learn how to use the telephone properly. It was no easy task to convince heads of firms that they really could use the telephone themselves with perfectly satisfactory results, but the Long-Distance Company succeeded in doing it and its patrons have become so finely educated in the manipulation of transmitter and receiver that they conduct their telephone interviews in the most business-like and matter-of-fact manner.

The prelude to the ordinary telephone conversation between persons to whom telephonic communication is not strictly a regular item in the daily round of business is something like this:

"Hello! Hello! Hello!"
"Hello! Hello! Well, who is it?"
"Hello! Who are you?"
"Who are you?"
"Oh! Well, this is Jones. Who are you?"
"Oh! Is that you, Jones?"
"Yes, I'm Jones. Who are you?"
"I'm Brown."
"What? Who?"

A Long-Distance Booth with Desk Set.

"This is Brown. How do you hear me?"
"Oh! Is that Brown?"
"Yes. Brown. How do you hear me?"
"Oh! I hear you pretty well. How do you hear me?"
"Oh! I hear you well enough."

"Well, what I wanted to say was that—Hello! Did you get that?"

"Yes go on, I hear you better now."

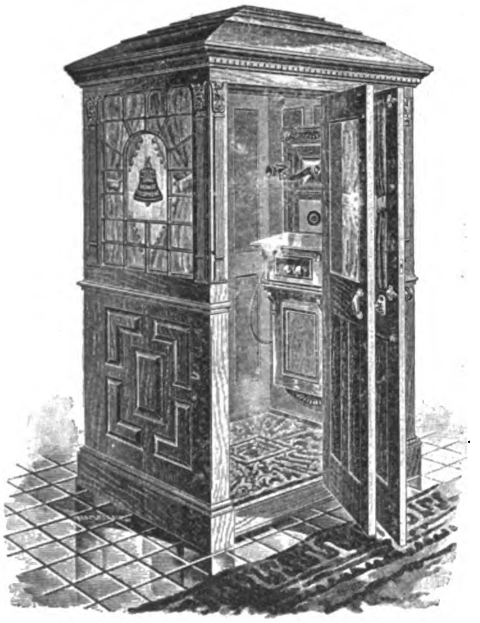
"Oh! all right. Well what I wanted to know was"—and so on.

Practised users of the long-distance wires indulge in no such extended preliminaries. For one thing conversations are generally by appointment and the parties are usually known to each other; while a second reason for promptitude is that the time allowed is limited and the line is being paid for all the time. Moreover the clearness of transmission is such that well-known voices are recognized at once and there is no more room for misunderstandings than there would be in an ordinary conversation when the talkers were in the presence of each other and only a few feet apart. The opening of a long-distance conversation is generally confined to simple salutations such as:

"Hello Smith!"

"Yes."

"This is Robinson. We have had an application from Blank & Co., of Detroit, for a consignment of goods on commission, what do you know about them?" and so on, until all the various matters to be discussed are reeled off without breaks or repetitions.



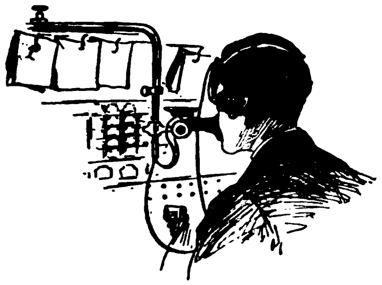
A Long-Distance Booth with Wall Set.

A surprising feature of long-distance telephony is the remarkable amount of business that can be crowded into a very short conversation. The fact that the communication obtained is an actual conversation at first-hand between the persons most directly interested in the matter under discussion is what renders the telephone so far superior to the telegraph for very many purposes. Question and answer are exchanged immediately without the annoying delays incident to telegraphic despatches. Propositions can be made and commented on, modified or rejected, in a manner quite impossible by telegraph; in fact all the advantages of a personal interview are obtained without the expenditure of time and trouble involved in a journey. Numerous instances could be given of the number of business questions that can be disposed of in a single talk over the wires within the minimum time of five minutes. Probably the best on record is that where two business men, one New York and one in Boston, discussed and settled four entirely distinct affairs in one minute and a half. Two of the matters dealt with involved large sums of money, but the men were able to lay their heads together, figuratively speaking, so well, although literally they were so far apart, that it took them but a few seconds in each case to decide on what should be done. It can readily be imagined how many telegrams would have been required to do the same amount of business, leaving entirely aside the question of time, which is so often of the first importance. Every day cases occur where the long-distance telephone enables business to be done that the telegraph cannot aid and where the only alternative would be a long and expensive journey. For instance, not long ago a New York man was notified that his draft on a house in a town far up in the interior of the State had been allowed to go to protest, and in order to protect his interests he was on the point of undertaking a journey that would have kept him away from his office for three days when a friend advised him to telephone to the bank who held the draft. He did so immediately; the bank informed him of the state of affairs and recommended a lawyer in the town to take the job in hand; he had an interview by telephone with the lawyer and gave him instructions to proceed, and the same afternoon the lawyer reported that he had got out an attachment and that the draft would be fully covered. The time spent by the New York man over the affair might have been an hour, and the total expense was for three conversations, one with the bank and two with the lawyer, as against an absence from town of two or three days and travelling expenses amounting to $40 or $50. The actual saving of time and money is by no means the only recommendation in favor of long-distance telephone communication. Often it renders possible the transaction of business which could be done in no other way, and many a time a five minutes' conversation pays for itself a thousand-fold. To manufacturers having their head offices in New York, branches in other cities and towns, and factories somewhere in the country, the service has become practically indispensable; the periodical daily talks between the chief of the firm and the manager of the factory or branch office place all their affairs so thoroughly in touch with each other that no manufacturing concern who has once adopted the service to its needs would be without it for a single day were the cost twice what it is. Bankers, brokers and lawyers form another large class of patrons, but it was among the manufacturers that the long-distance telephone first "caught on" and they have steadfastly availed themselves of it from the time of its establishment as a commercial means of communication.

XIX.

The excellent transmission over the long-distance lines has made it possible to organize a novel kind of entertainment in the form of telephonic concerts. When the system is extended to a new place the capabilities of the telephone are sometimes shown off to an admiring public by giving an inaugural telephonic entertainment the programme being made up of vocal and instrumental music and recitations delivered at New York or some other distant point and transmitted over the wires to the concert hall. These telephonic entertainments have a great fascination for the public and they are remarkably effective in showing the telephone at its very best. The Long-Distance Company has taken considerable pains in arranging transmitters and receivers suitable for the transmission of music and the dissemination of the sound through a large hall. It will be remembered that the chief attraction of the electrical exhibition held about two years ago at the Lenox Lyceum, in New York, was the telephone exhibit, where the performances at several of the New York theatres were on tap during the evening, recitations were given from Boston and the roar of Niagara Falls could be heard over the long-distance wires. Quite elaborate concerts have been given in New York and every note has been clearly transmitted to audiences assembled in Boston, Washington and Philadelphia. Not very long ago an entertainment conducted in New York was delivered at the same time to three separate and distinct audiences, one in Philadelphia, one in Baltimore and one in Washington. A general programme was announced over the wires by a speaker in New York before the concert began and each number was separately announced in the same manner. The ensemble of the orchestra was perfectly reproduced in each place and the solos rang out as distinctly and clearly as if the singers had been in all three places at once. After each performance thunders of applause came rolling over the wires from Washington, Baltimore and Philadelphia.

Another interesting example of the transmission of music by telephone occurred about a year and a half ago, when Strauss's famous orchestra was performing at the Madison Square Garden. A telephonic entertainment was given from New York to a large audience assembled at the Grand Union Hotel at Saratoga. A circuit was run from the Long-Distance Company's operating-room to the Madison Square Garden and selections from the concert given by the Strauss orchestra were switched on in alternation with flute and cornet solos, songs, glees and recitations given by musicians and vocalists assembled at Cortlandt street. The performance was heard all over the room at Saratoga by means of a single loud-speaking receiver provided with a large funnel-shaped resonator to magnify the sound. On the same evening Mr. A. S. Hibbard, the general superintendent of the Long-Distance Company, was entertaining a number of friends at his house in Morristown, N. J. Mr. Hibbard's private line was connected at Cortlandt street with the circuit running to Madison Square and the strains of the famous orchestra were heard so plainly in the house at Morristown that the guests there assembled danced to Herr Strauss's waltzes as if he had been waving his baton under the same roof instead of under one nearly 30 miles distant.



"*Good Bye.*"

QUARTZ FIBRES FOR SUSPENSION PURPOSES.

In the electrical laboratory of Queen & Co., Philadelphia, have recently been made a series of careful experiments upon the properties of quartz fibres for use in suspending galvanometer systems and in other physical measurements, as compared with fibres of glass, metal and cocoon silk. These tests have shown conclusively that quartz fibres are so greatly superior to all others in every way that the above-mentioned firm have decided to prepare them for sale, and the following details will be of much interest to our readers.

These fibres are drawn in the oxy-hydrogen flame from pure rock quartz, their diameter being regulated by the speed of drawing. As to size it is possible to draw them from those too fine to manipulate (less than $\frac{1}{10000}$ inch) up to rods $\frac{1}{10}$ inch in diameter, and in lengths (for diameters less than $\frac{1}{10000}$ inch to $\frac{1}{100}$ inch) as desired. Inspection with a microscope shows that they are extremely uniform in diameter and contain no "fishes" or flaws of any kind.

The principal advantages possessed by quartz fibres over all others are, first, perfect elasticity; they show absolutely no "Nachwirkung" or "set" and, when twisted, come back to the same position immediately; it is thus possible to reach a much higher degree of sensibility with a galvanometer using a quartz fibre in place of unspun silk, for, as is well known, a cocoon fibre, to which is attached a system under small controlling force will not return at once to the zero point within five per cent. of the total deflection. Quartz fibres are also absolutely unaffected by ordinary changes of temperature or atmospheric conditions, whereas silk fibres, absorbing greater or less amounts of moisture at different times will have correspondingly different zero points.

The tensile strength of quartz fibres is from 50 to 70 tons per square inch which is nearly as great as the best steel, and many times that of silk. Fibres of extreme fineness may, consequently, be used; as for example, a quartz suspension $\frac{1}{10000}$ inch in diameter will sustain a weight of one-half gram. They are, however, very easily broken by lateral stress and they are therefore raised or lowered as a whole instead of attempting to bend them around a spindle, although the finer ones can be successfully wound upon spindles of one-half inch or greater diameter.

The uses of quartz fibres are various; they can be employed advantageously for the suspension of all delicate electrometer and galvanometer suspensions. They may also, as suggested by Mr. Boys, be used to suspend very small bodies, the specific gravities of which are required, as there is practically no capillary attraction between the fibre and water. Being unaffected by heat and of very uniform diameter they are excellent for use as cross-hairs in telescopes and microscopes.

For further information regarding quartz fibres see a paper by C. V. Boys "On the Production Properties and Some Suggested Uses of the Finest Fibres," *Philosophical Magazine*,, 1887; also a paper by Prof. Richard Threlfall on "Elastic Constants of Quartz Threads," *Ibid*, 1890.

SHORT'S METHOD OF STOPPING ELECTRIC LOCOMOTIVES.

Heretofore in electric railway work it has been largely customary to reverse the current in order to stop the car quickly, which results in a considerable waste and causes a tendency to burn out the motors. In order to obviate this difficulty, Mr. Sidney H. Short, of Cleveland, Ohio, has devised an arrangement by means of which the motors are disconnected from the ordinary supply-wire and connected in a local circuit with each other in such a way that the current generated in the local circuit and acting on a motor, tends to check the forward movement of the car. The two motors of a car are connected in the local circuit so that the electromotive force of each under the rotation imparted by the forward movement of the car opposes that of the other and tends to produce a current in such a direction as to increase its own field magnetism and cut down that of the other. The car will thus be checked or brought to a sudden stop if running rapidly, and, if on a heavy grade, will creep slowly down without taking current from the supply wire and without having the brakes set. In effecting this, one motor overpowers the other, owing to the difference in the residual magnetism of their fields, and reverses the field polarity of the weaker motor, which is thereupon operated in such a direction as to run the car backward by the current from the more powerful motor, acting as a generator.

REPORTING AN ENGLISH BOAT RACE.

The celerity of telegraphic communication was well exemplified at the recent Oxford-Cambridge University boat race on the Thames. The press boat, as it steamed up the Thames, paid out a cable over the whole length of the course, and at each important part of the race a telegraphic message was despatched by the Press Association. The result was that within a minute of the boats passing any well-known landmark, the clubs in London were informed of their positions. Furthermore, papers were to be bought in Trafalgar Square giving full details of the race at 12.41, within six minutes of the arrival of the Oxford crew at the winning post.

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Vol. XIII. NEW YORK, MAY 11, 1892 No. 210.

> ***The truth of science has ever had, not merely the task of evolving herself from the dull uniform mist of ignorance; but also that of repressing and dissolving the phantoms of imagination which ever rise up in new and tempting shapes, and which not being of her, crowd before and around her and embarrass her way.—Faraday.***

THE EDISON TELEPHONE PATENTS.

THE American Bell Telephone Company have been in some respects singularly fortunate in the essential character of the patented inventions upon which their business has been based. The original invention of Alexander Graham Bell has been held by repeated adjudications of the courts to embody a novel art or process of transmitting articulate sounds by undulatory vibrations of electricity. Not only that, but a very general consensus of opinion among scientific men has been that no method of transmission of speech by electricity other than by means of undulatory currents, is in the least likely to prove practicable and successful. It follows, therefore, as Justice Gray held in the Dolbear case in 1883, that "if that art or process is the only way by which speech can be transmitted by electricity, that fact does not lessen the merit of his (Bell's) invention, or the protection which the law will give to it."

Soon after the invention of Bell began to be practically used, it became apparent that for speaking over lines of any length superior results might be expected if a practicable means could be discovered of varying the strength of a battery current by the action of the vocal vibrations, a conception which Bell himself had suggested in his patent. Contacts of variable resistance made of carbon were soon found to be the desideratum, and it is a singular fact that, although thousands of substances have been tested and years of experiment have been devoted to the subject, carbon remains to-day practically the only known material which will satisfactorily fulfil the conditions of this service.

In the year 1877 and subsequently a number of applications for patents were filed by different inventors of telephone transmitters making claim, in one form and another, to the "carbon contact," and after the lapse of 15 years, due to protracted proceedings in the Patent Office to determine who was the original and prior inventor, the contest terminated in the issue on May 3, 1892, to the Western Union Telegraph Company, as assignee of Thomas A. Edison, of three patents, one of which is a broad patent covering the use of a carbon contact in a telephonic transmitter; which patents, under the provisions of an existing contract, will inure to the benefit and behoof of the American Bell Telephone Company.

The text of the most important patent, omitting certain portions referring solely to an electro-chemical receiver, (which are not relevant to the matter under discussion), is given elsewhere in our columns. It would appear that inasmuch as this patent covers the use of "plumbago"—which is a well-known form of carbon—as well as "other similar inferior conductor," it resembles the Bell patent in the particular that it claims the only instrumentality, so far yet known, by which speech can be successfully transmitted by the variation of a battery current, and hence unless some other means of varying the current can be discovered which does not involve the use of semi-conducting electrodes at the points of contact of the circuit, this patent, if sustained, will effectually protect the most important and valuable portion of the business of the American Bell Telephone Company.

In discussion of the question of the probable validity of the patent two points may be taken to be pretty well established: first, that Edison was the prior inventor of the combination he has claimed, and second, that no legal presumption against the validity of the patent necessarily arises from the fact that it has been pending fifteen years in the Patent Office and that meantime the invention has gone into extensive public use all over the world.

The impression appears to be quite general that there exists an unsettled question of priority between Edison and Hughes in reference to the discovery of the microphone. However this may be, it is a question wholly aside from the present one; for the records show that Edison's invention, now patented, must have been made prior to July 9, 1877, while the earliest publication of Hughes's experiments, in which he described carbon contacts, was not made until May of the year following. As to the other point, it is sufficient to cite the well-known case of the Simpson patent on gutta-percha insulation for electric wires, the application for which was pending in the Patent Office from 1848 to 1867, a period of 19 years, during which the invention was in universal use everywhere. The patent was nevertheless sustained almost without question on this point, although the merit of the inventor was much less obvious than it is in the present case.

The most important question which will arise in the adjudication of this patent will doubtless be in connection with the much-discussed statute limiting the life of a domestic patent by that of the prior foreign patent for the same invention having the shortest time to run. In the present case there are at least nine foreign patents for substantially the same invention, all of which bear date subsequent to the application, but prior to the grant, of the domestic patent. Some of these foreign patents as, for instance, the British patent of July 30, 1877, have already expired; others are, presumably at least, still in force. The real question is therefore, is it the date of the application or the date of issue of the domestic patent that is to govern? The decisions of the circuit courts on this point have been various and conflicting, but the more recent ones appear to have pretty consistently held that the date of *issue* is the controlling one, and hence that the expiration of a foreign patent of prior date, would, upon principle, render the domestic patent void *ab initio*. But in the case of *Bate Refrigerating Co.* v. *Hammond*, decided by the Supreme Court on appeal from the Circuit Court, the decision of this question was studiously evaded. The court expressly declined to pass upon the affirmative proposition that the priority of the foreign patent is determined by the respective dates of application for the foreign and domestic patents, and not by the date of issue of the domestic patent. As the law now stands, therefore, it would seem that the Edison telephone patents are void; but when the question comes squarely before the Supreme Court for decision, as it undoubtedly will in due time, it is perhaps an even chance whether the decisions of the circuit courts will not be overthrown. This delightful state of legal uncertainty as to the very existence of a property of enormous possible value, is a significant commentary upon the results of an absurd provision which was injected into the patent law, nobody knows by whom, or for what purpose, unless it may perchance have been for the benefit of patent lawyers, to whom it has certainly proved a veritable bonanza.

THE COST OF ELECTRICITY IN AGRICULTURE.

The proposal to employ new methods in any department of work, which has been subject to practically no change for long periods of time, naturally arouses the interest of all concerned, especially if the proposed change promises to bring about large economy in operation or production. The experiments which are now being undertaken by the Department of Agriculture in the application of electric motive power to the operation of farm implements therefore have a wide significance; for if it can be shown that there, as in the case of the street railway, the horse can be properly displaced by the electric motor, an enormously wide field will be opened to the latter. Recent articles in The Electrical Engineer, by Mr. A. A. Denton, of the United States Experimental Agricultural Station at Sterling, Kansas, have well shown the advantages which could be derived from the application of the electric motor to farming operations. The cost of electric motive power as compared with horses must, of course, be the deciding factor in this intended change, and we have, therefore, thought it well to bring out the results arrived at by Prof. R. C. Carpenter, of Cornell University, on this point, in order to point out some apparent discrepancies which are apt to lead to a misunderstanding of the true nature of the problem involved.

Taking up the question of the power to operate the motor, Prof. Carpenter assumes that it would require a 75 h. p. engine and boiler to develop 25 h. p. at the motor shaft. Based on these figures he calculates the cost of such a system approximately as follows:

Cost of 75 h. p. steam plant	$3,750 to	$4,500
Cost of dynamo, 60 h. p. at $30	1,800 "	1,800
Cost of 25 h. p. motor	1,000 "	1,000
Cost of wire, 1 mile and return	500 "	500
	$7,050 to	$7,800
The cost per h. p. delivered (21)	326 "	372

And as to the probable cost of operation he calculates:

The engine would require 2 tons of coal per day at $4	$8.00
The help, engineer and motor man, $2 each	4.00
Making the cost of operation	$12.00
To this must be added a man or laborer	1.50
	$13.50
The cost of operating 21 horses can be taken at current rates; for man and team at $2.50 per day, it would be	$26.50
So that there would seem to be a net gain from the use of the motor of (per day)	$13.00

In the case of the team the charge is sufficient for repairs, renewals and interest. These items would certainly be in the case of the motor one-half more, so that the net saving would be less than $7 per day.

We must, however, take exception to what we believe is an overestimate on the part of Prof. Carpenter of the amount of engine power required to deliver 25 h. p. at the motor shaft. Allowing an efficiency of 80 per cent. in the generators, a like efficiency in the line, that is, a drop of 20 per cent., and an efficiency of 80 per cent. in the motor, the engine power required would still be a trifle under 50 h. p. So that not only in the item of first cost of boiler and engine and dynamo, but also in the cost of operation a considerable reduction would be permissible. Even taking Prof. Carpenter's figures as they stand, there is shown a gain in the use of the electric motor, which even on this small scale is quite appreciable.

In discussing this question an important point must not be lost sight of, namely, that to base the economy of operation upon figures representing 25 h. p. delivered, is to leave out of consideration the ultimate shape which electrical distribution for agricultural purposes would assume. For a proper basis of calculation we must assume a central station of several hundred or thousands of horse power, from which radiate lines in all directions and to a distance limited only by the potentials which are now available. The cost of producing one horse power delivered under such conditions must differ widely from the case assumed by Prof. Carpenter. Nothing could be more simple than the establishment of such a station on the alternating plan, distributing current at high pressure on small wires with numerous taps or junctions where a converter could be inserted, and from which current at low pressure could be furnished to alternating motors without commutators, which would in itself be a gain from a mechanical standpoint. By establishing numerous current outlets, the difficulties encountered in paying out long lengths of cable is avoided, and thus one of the objections to this mode of power distribution to farming implements is overcome.

We hope that the appropriation asked for in the bill introduced by Senator Peffer will be granted, for although we do not deem the amount at all sufficient to carry the experimental work to completion, it will suffice to make a start in a field of the highest importance to all engaged in electrical work. We believe, indeed, that all manufacturers of electrical apparatus ought to lend their aid and co-operation for reasons which are obvious, to the successful carrying out of these experiments.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—X.

BY

Francis B. Crocker and S. S. Wheeler.

CHAPTER VII (*Continued*).

4. Balance.—The perfection of balance of the armature or pulley can be roughly tested by simply running the machine at its normal speed and noting if these parts are sufficiently well balanced not to cause any objectionable vibration. Of course, practically every machine produces perceptible vibration when running, but this should not be more than a slight trembling. The balance of a machine can be definitely tested and the extent of the vibration measured by suspending the machine or mounting it on wheels and running it at full speed. In this case it is better to run the machine as a motor, even though it be actually a dynamo, in order to make it produce its own motion, so to speak, and avoid the necessity of running it by a belt which would cause vibration and interfere with the test. If, however, the use of a belt is unavoidable, it should be arranged to run vertically upward or downward so as not to produce any horizontal motion in addition to the vibration of the machine itself. Fig. 21 shows a machine hung up to be tested for balance and run either as a motor or by the vertical belt indicated as a dotted line. Any lack of balance will cause the machine to vibrate or swing horizontally, and this motion can be measured on a fixed scale.

5. Noise.—This cannot be well tested quantitatively, although it is very desirable that a machine should make as little noise as possible. Noise is produced by the various causes given in the chapters on Locating Faults. The machine should be run at full speed and any noise and its cause carefully noted.

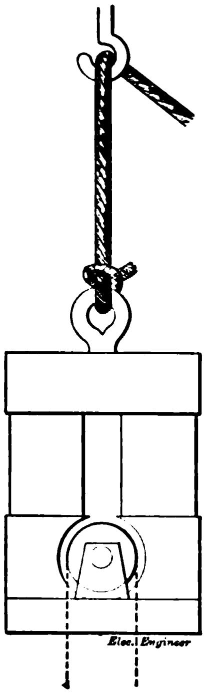

FIG. 21.

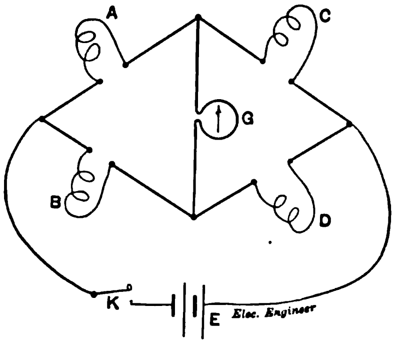

FIG. 22.

6. Electrical Resistance.—There are two principal classes of resistance tests that have to be made in connection with dynamos and motors. First, the resistance of the wires or conductors themselves, which might be called the *metallic* resistance; and second, the resistance of the insulation of the wires, which is called the *insulation* resistance. The former should usually be as low as possible, the latter should always be as high as possible, because a low insulation resistance not only allows current to leak, but also causes "burn-outs" and other accidents. Metallic resistance, such, for example, as the resistance of the armature or field coils, is commonly tested either by the Wheatstone bridge or the "drop" (fall of potential) method.

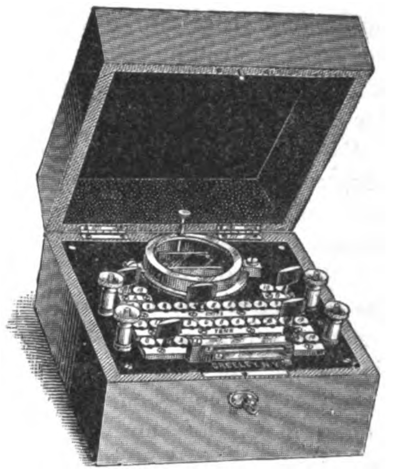

FIG. 23.—PORTABLE WHEATSTONE BRIDGE.

The Wheatstone bridge, Fig. 23, is simply a number of branch circuits connected as indicated in Fig. 22. A, B and C are resistances the values of which are known. D is the resistance which is being measured. G is a galvanometer and E is a battery of one or two cells controlled by a key K, all being connected exactly as shown. The resistance C is varied until the galvanometer shows no deflection when the key K is closed. The value of the resistance D is then found by multiplying together resistances C and B and dividing by A; that is, $D = \frac{C \times B}{A}$. A very convenient form of this apparatus is what is known as the portable bridge. This consists of a box containing the three sets of known resistances A, B and C controlled by plugs, also the galvanometer G and key K, all connected in the proper way. In some cases the perfection of convenience is reached by including the battery E in the box also, but ordinarily this is not done and it is necessary to connect one or two cells of battery to a pair of binding posts placed on the box for that purpose. Resistances from $\frac{1}{10}$ ohm to 100,000 ohms can be conveniently and accurately measured by the Wheatstone bridge. Below $\frac{1}{10}$ ohm the resistances of the contacts in the binding posts and plugs are apt to cause errors. In fact, in measuring any resistance care should be taken to make the connections clean and tight. The ordinary bridge will not measure above 100,000 ohms because if the resistance in the arm B is 100 ohms, 1 ohm in A, and 1,000 ohms in C, then D is 100,000. Sometimes the arms A and B are provided with 1,000-ohm coils in addition to the usual 1, 10 and 100 ohm coils, or sometimes the arm C contains more than 1,000 ohms in all; in either case the range will be correspondingly increased. The bridge may be used for testing the resistance of almost any field coils that are found in practice. Shunt fields for 110-volt machines usually vary from about 100 or 200 ohms in a 1 h. p. machine to about 10 or 20 ohms in a 100 h. p. machine. If the voltage is higher or lower than 110 these resistances vary in direct proportion. Series fields for arc circuit dynamos or motors vary from about 1 to 20 ohms.

The bridge may also be used for testing the armature resistance of most machines. But 110-volt shunt machines above 10 h. p. usually have resistances below $\frac{1}{10}$ ohm, which is below the range of the bridge, as already stated. Higher voltage dynamos and motors have proportionally higher resistance armatures. Arc machines have armatures of about 1 to 20 ohms resistance and are therefore easily tested by the bridge.

The "drop" or fall of potential method is well adapted to testing the armature resistance of large incandescent dynamos or the resistance of contact between commutator and brushes or other resistances which are usually only a few hundredths or even thousandths of an ohm. This consists in passing a current through the armature and a known resistance of, say, $\frac{1}{100}$ ohm connected in series with each other, as represented in Fig. 24. The "drop" or fall of potential in the armature and in the known resistance are then compared by connecting a galvanometer first to the terminals marked 1 and 2 and then to 3 and 4. The deflections of the needle in the two cases are proportional to the resistances. The current needed depends upon the sensitiveness of the galvanometer, but should not require more than a few cells of battery. If a galvanometer is not at hand, the drop method can be used with a strong current and a voltmeter, the connections being the same as in Fig. 23. The current required in this case depends upon the resistance to be measured, but it must of course be sufficient to produce a readable deflection on the voltmeter. Usually 10 to 100 amperes and a voltmeter reading to a single volt or fractions of one volt are needed for low resistances.

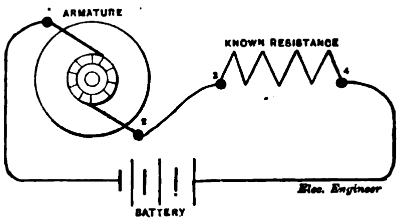

FIG. 24.

It is wise to start with a small current and increase it until a reasonably readable deflection is obtained on the voltmeter. The current may be obtained by using a cell of storage battery, or a few cells of some strong primary battery such as a plunge battery, Bunsen or bichoromate battery. The current may also be taken from another dynamo or from a circuit, but a bank of lamps or a liquid resistance should then be used to control the current, as the armature alone, of course, has very little resistance. A convenient form of liquid resistance for this purpose is described hereafter in the directions for testing current (No. 8.)

The insulation resistance of a dynamo or motor, that is, the resistance between its wires and its frame should be at least one megohm per hundred volts E. M. F., and it is, of course, better if it is much higher. It is therefore beyond the range of ordinary Wheatstone bridge tests, but there are two good methods which are applicable—the "direct deflection" method and the voltmeter method. The direct deflection method is carried out by connecting a sensitive galvanometer such as a Thomson high resistance reflecting galvanometer (tripod or square pattern) in series with a known high resistance, usually a 100,000 ohm rheostat, a battery and a key as shown in Fig. 25. The galvanometer should be shunted with the $\frac{1}{999}$ coil of the shunt so that only $\frac{1}{1000}$ of the current passes through the galvanometer, the machine being entirely disconnected. The key is closed and the steady deflection noted. It is well to use only one cell of battery at first and then increase the number if necessary until a considerable deflection is obtained. One of the wires is then connected to the binding post or commutator of the dynamo or motor and the other to the frame or shaft of the machine as indicated by dotted lines. The key is closed and the deflection noted. Probably there will be little or no deflection on account of the high insulation resistance, and the shunt is changed to $\frac{1}{99}$, $\frac{1}{9}$ or left out entirely if little deflection is obtained. In changing the shunt, the key should always be open, otherwise the full current is thrown on the galvanometer. The insulation is then calculated by the formula: Insulation resistance $= \frac{D \times R \times S}{d}$, in which D is the first deflection without the machine connected and d the deflection with the insulation in the circuit, R the known high resistance and S the ratio of the shunt. That is, if the shunt is $\frac{1}{999}$ in the first test and $\frac{1}{9}$ in the second, then S is 100, and if the shunt is out entirely in the second test S is 1,000. It is safer to leave the high resistance in circuit in the second test to protect the galvanometer in case the insulation resistance is low. Therefore this resistance must be subtracted from the result to obtain the insulation itself. By the above method it is possible to measure 100 megohms, or even more. The wires and connections should be carefully arranged to avoid any possibility of contact or leakage which would spoil the test.

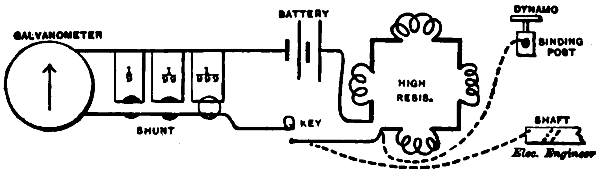

FIG. 25.

The voltmeter test for insulation resistance requires a sensitive high resistance voltmeter such as the Weston. Take, for example, the 150-volt instrument which usually has about 15,000 ohms resistance; apply it to some circuit or battery and measure the voltage. This should be as high as possible; say, 100 volts. The insulation resistance of the machine is then connected into the circuit as indicated in Fig. 26. The deflection of the voltmeter is then reduced in proportion to the value of the insulation resistance. The insulation is then found by the equation : Insulation resistance $= \frac{D \times R}{d} - R$, in which D is the first, and d the second deflection and R the resistance of the voltmeter. If the circuit is 100 volts then D is 100 ; and if d, the deflection through the insulation resistance of the machine, is 1 division, then the insulation is: $(100 \times 15{,}000) - 15{,}000 = 1{,}485{,}000$ ohms. This method does not test very high resistances, but if little or no deflection is obtained through the insulation resistance it shows that it is at least several megohms, which is high enough for practical purposes.

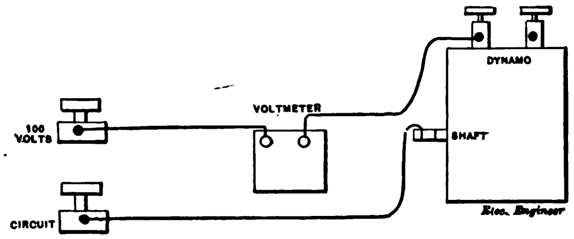

FIG. 26.

The ordinary magneto bell may be used to test insulation by simply connecting one terminal to the binding post of the machine and the other to the frame or shaft.

A magneto bell is rated to ring through a certain resistance, usually from 10,000 to 30,000 ohms, and if it does not ring it shows that the insulation is more than that amount. This limit is altogether too low for proper insulation in any case, and therefore this test is rough and really only shows whether the insulation is very poor or the machine actually grounded.

THE BUCARAMANGA, U. S. C., ELECTRIC LIGHT PLANT.

The electric light is making steady progress in South and Central America, and several electric light stations recently installed in those regions have been described in our columns. Among the plants which have been particularly successful from the start is that now in operation at Bucaramanga, U. S. of Colombia, which was installed by Mr. Julio Jones for the Thomson-Houston International Electric Co., and, considering the obstacles encountered, reflects great credit on his perseverance and ability. These obstacles were numberless, some arising from natural causes, some from the great backward state of civilization of the country, and some from evil spirit in the people. Among the first may be mentioned the difficulties in transportation of the heavy pieces of machinery, the total weight of which amounted to about 25,000 pounds. This, of course, refers only to pieces weighing between 200 and 1,400 pounds, all small apparatus having been packed in 150-pound packages for mule transportation, so that a mule could carry two such packages weighing 300 pounds at the most. But even with this weight it is a wonder that a mule can travel over the mountains through such roads as there exist. All the small packages were carried by about 200 mules.

Of the 25,000 pounds about one-half consisted of pieces under 400 pounds weight and such were carried by oxen, some on their backs, others dragged over the ground on frames of timber, it being impossible to make use of carts or any wheeled vehicles on such roads, the condition of which is almost beyond description. In some parts stones of great size lie across the road, leaving narrow passages of only two or three feet width; in others the ground has the shape of a V and then this sort of canal, called a road, is curved or zigzagged for the purpose of climbing up a steep hillside, reducing the grade of the road to about 30° or more, and making it a sort of staircase, some steps of which are so high, that mules which are not strong enough fall right back on the top of their load in attempting to jump up. And it was over such roads that pieces which weighed as much as 1,400 pounds had to be carried by men on their shoulders for a distance of about 25 miles. Such pieces would take not less than 60 men each, the modus operandi being to tie two long poles of wood to the piece, one on each side and then short ones across these two for the men to put their necks under. Pieces aggregating a weight of about 12,500 pounds were carried by such means.

But there was another transshipment which is perhaps of greater interest, the transportation in canoes through a portion of the Lebrija River, which had never until then been navigated. Coming from the coast, the city of Bucaramanga is reached as follows: First, ascending the Magdalena River by steamer to the mouth of the Lebrija River which is not navigable for steamers; here transshipped to canoes or "dug outs." These canoes are about 30 or 40 feet long, 3 to 5 feet wide and 2 to $2\frac{1}{2}$ feet deep, and are manned by negroes, called "bogas"; the canoes are laboriously poled up the stream by six or seven of these men.

The Lebrija is thus navigable up to the port named Botijas, about 35 miles from the city. From this place up it is almost impossible to navigate, as the rapids become more frequent, and exceedingly dangerous; and yet for the purpose of avoiding a piece of road over a mountain, through which it would have been quite impossible to travel with the larger pieces of machinery, it became indispensable to continue the navigation for about eight miles up to a place where they could be landed near the road and thence carried away. In some of these rapids they had to make use of a winch, which after being secured in some convenient place above the rapid, served to pull up the canoe with a strong cable. What this task was, can be conveyed best by stating that it took three days of hard labor to go up the eight miles, and only 30 minutes to go down. Three such trips had to be made with two canoes each time, in order to transport all the heavy machinery, the direction of the work being taken personally by Mr. Jones.

Having landed the materials on the ground, next came the construction of the station on the side of the Surata River, which offered serious difficulties in consequence of the great scarcity of laborers, and want of intelligent and skilled workmen, especially of masons, not one being found that knew his business, besides a complete absence of facilities for doing the most ordinary kind of work; for in this land man has nothing but his hands for tools. The principal piece of machinery was a small winch, with which two men could lift about a ton, and which, applied to a crane which was set up, served to build some large stone walls,

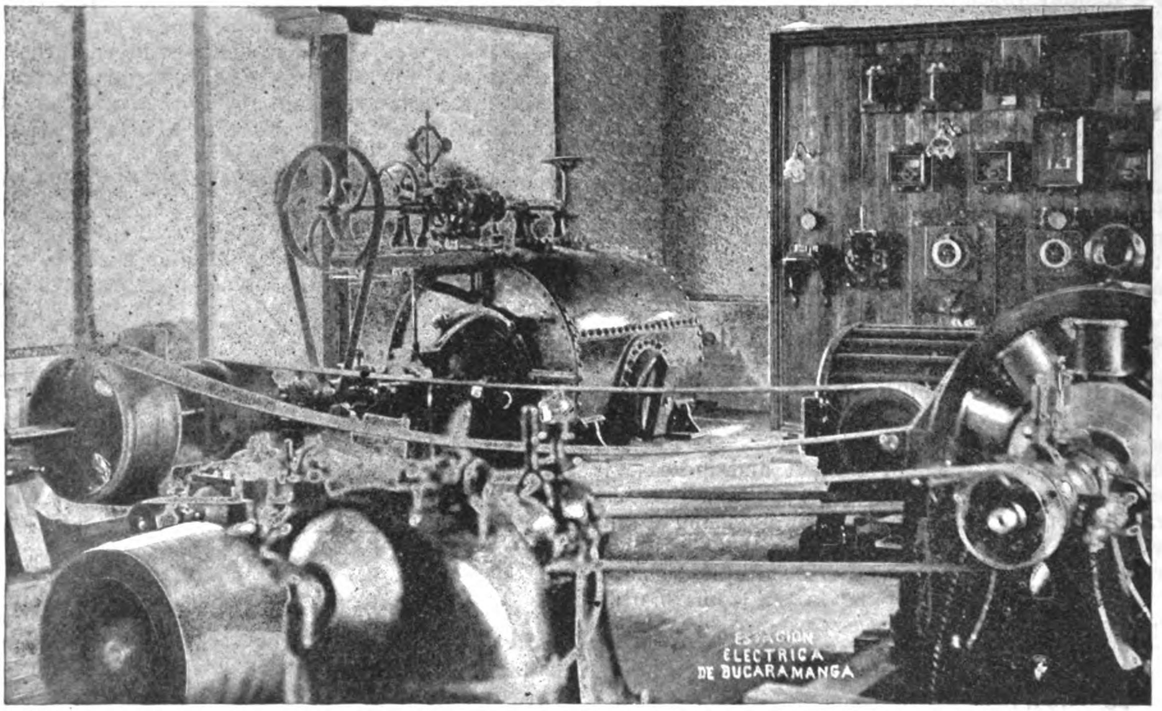

FIG. 1.—DYNAMOS AND TURBINE, BUCARAMANGA ELECTRIC LIGHT PLANT.

made out of heavy coarse stones. The place for the station had to be hewn out of a steep hillside composed mostly of huge rocks, which had to be blasted, and the construction of the ditch which runs along a steep hillside was a matter of considerable work.

Work was first begun in September, 1890, and the definite inauguration of the arc lighting took place on November 20, 1891. The incandescent light was inaugurated on December 26 of last year, and both have since been continued running together without interruption and with the greatest satisfaction.

The Bucaramanga electric station is located on the banks of the Surata River, 2½ miles away from the city. It is a two-story building largely made of stone and brick, which measures 44 x 24 feet. The upper story is divided into a large dynamo-room and a small room for the engineers. A third of the first story is occupied by the tail-race of the turbine wheels, and a water tank 13 x 19 feet, the rest forming a large room, which can, later on, be made into a dynamo-room. On one extremity of the tank there is built up an elliptical brick arch, which serves as a support for the wheels, as well as for the corresponding parts of the walls of the upper story and roof of the house. It is, consequently, very solidly built and is 13 feet span, 4 feet rise, 6 feet long and 3 feet deep. Upon this arch the flume of the turbines is solidly set, so that it occupies a corner of the dynamo-room on the second floor, as shown in Fig. 1.

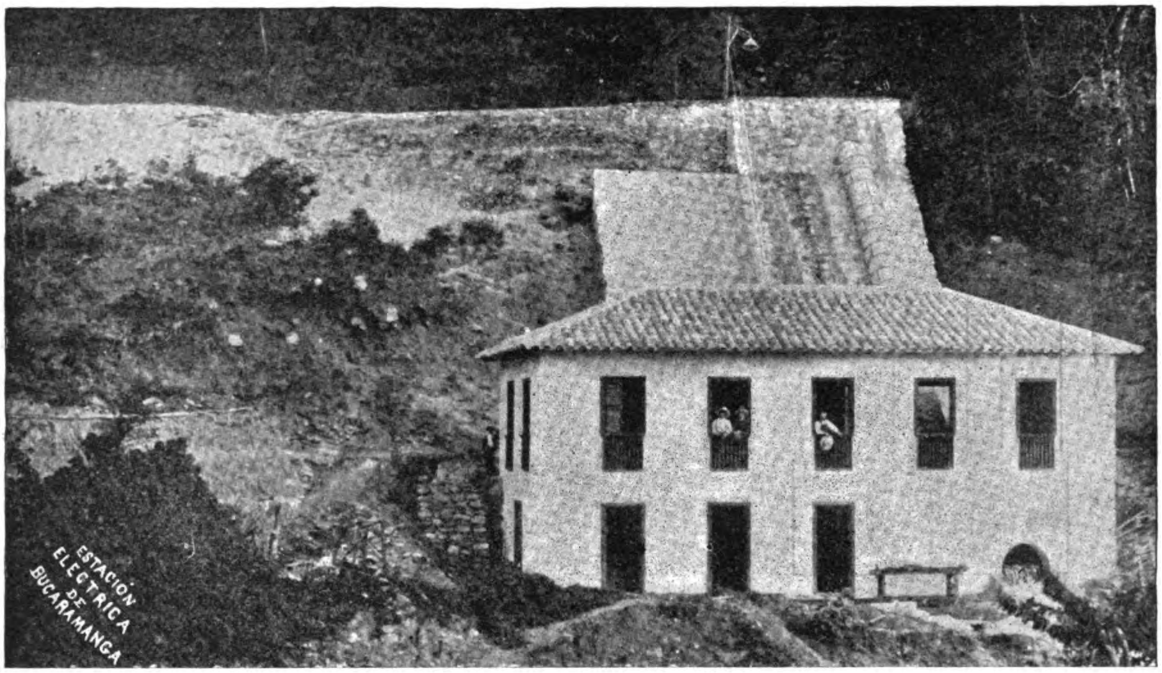

FIG. 2.—ELECTRIC LIGHT STATION, BUCARAMANGA, U. S. C.

The turbines were furnished by the Rodney-Hunt Machine Co., of Orange, Mass. They are a pair of 12-inch wheels on a 3-inch horizontal shaft encased in a steel flume, made of ½-inch steel plates 4 feet 6 inches in diameter by 4 feet 10 inches long. The penstock is built of $\frac{3}{16}$ inch iron plate and is all divided up into small pieces for ease in transportation, which pieces are all secured by bolts instead of being riveted. It is 42 inches in diameter and about 45 feet long. It comes out of a brick pressure tank, shown in Fig. 2, and tending downwards it descends at an angle of 53 degrees and finally bends again to enter the flume horizontally.

The wheels are capable of developing 160 h. p. They work under a head of 50 feet, which is divided up as follows : 5 feet in the pressure tank to the entrance of the penstock, 35 feet thence to the centre of wheels and 10 feet of draught fall. The wheel governor, which was also made by the Rodney-Hunt Machine Co., is a double-action governor, and is mounted on top of the wheel. It regulates the speed admirably, adjusting the supply of water to the wheels exactly in accordance with the expenditure of power required by electric machines. The wheels vent 2,100 cubic feet of water per minute when working at full capacity, and revolve with a speed of 780 revolutions per minute. The main shaft from which power is transmitted to the dynamos is simply an extension of the wheel-shaft, to which it is directly connected, and is likewise a 3-inch shaft.

The switchboard is placed in front of the wheels and next to it are placed in a comparatively small space the four dynamos now in use, leaving sufficient space in the same room for three more of them, there being also a surplus of power in the wheels sufficient to run another set of machines equal to those which are now in operation. The dynamo machines, all furnished by the Thomson-Houston International Electric Co., are as follows: One arc dynamo capable of maintaining 30 1,200 c. p. arc lamps; one incandescent dynamo of the alternating current type capable of maintaining 650 16 c. p. incandescent lamps by the transformer system. This machine is adjusted for 20 per cent. loss, so that it automatically maintains constant pressure at the terminals of the transformers in the city at 1,100 volts, the voltage of the transformed current being 52 volts; and an exciter dynamo for exciting the magnetic field of the alternator. This little dynamo is capable of exciting the field of four such machines; its remaining capacity is used at present for supplying the incandescent lamps at the station. There is also one 20 h. p. generator adjusted for a loss of 25 per cent., so that it automatically maintains a constant electromotive force of 500 volts at the terminals of the electric motors placed in the town.

There is a second set of potential indicators placed at the distributing station which is located in the centre of the city and there pressure is kept constant at 54 volts. The lights burn well and all with equal brilliancy throughout the city, and the people are delighted with them. Among the convenient arrangements is one for transferring the current from one lamp to another placed at a distant point by means of three-way switches, etc. At the station the lighting is done with incandescent 52-volt lamps, two in series, supplied with the current from the exciter, the pressure of which is kept at 106 volts, the wiring being laid out for 2 per cent. loss.

DYNAMO-ELECTRIC MACHINERY.—II.[1]

BY J. HOPKINSON, F. R. S., AND E. WILSON.

EFFECTS OF THE CURRENT IN THE ARMATURE.

Quoting from the Royal Society Paper, p. 342, "The currents in the fixed coils around the magnets are not the only magnetizing forces applied in a dynamo machine; the currents in the moving coils of the armature have also their effect on the resultant field. There are in general two independent variables in a dynamo machine—the current around the magnets and the current in the armature, and the relation of E. M. F. to currents is fully represented by a surface. In well-constructed machines the effect of the latter is reduced to a minimum, but it can be by no means neglected. When a section of the armature coils is commutated it must inevitably be momentarily short-circuited, and, if at the time of commutation the field in which the section is moving is other than feeble, a considerable current will arise in that section, accompanied by waste of power and destructive sparking.

"Suppose the commutation occurs at an angle λ in advance of the symmetrical position between the fields, and that the total current through the armature be C, reckoned positive in the direction of the resultant E. M. F. of the machine, *i. e.*, positive when the machine is used as a generator of electricity. Taking any closed line through magnets and armature, symmetrically drawn, as A B C D E F A, Fig. 2, it is obvious that the line integral of magnetic force is diminished by the current in the armature included between angle λ in front and angle λ behind the plane of symmetry. If m be the number of convolutions of the armature, the value of this magnetizing force is $4\,\pi\,C\,\frac{m}{2}\,\frac{2\lambda}{\pi} = 4\,\lambda\,m\,C$ opposed to the magnetizing force of the fixed coils on the magnets. Thus, if we know the lead of the brushes and the current in the armature, we are at once in a position to calculate the effect on the E. M. F. of the machine. A further effect of the current in the armature is a material disturbance of the distribution of the induction over the bored face of the pole-piece; the force along B C is by no means equal to that along D E. Draw the closed curved B C G H B, the line integral along C G, and H B is negligible. Hence the difference between force H G and B C is equal to $4\,\pi\,C\,\frac{m}{2}\,\frac{\kappa}{\pi} = 2\,\kappa\,m\,C$, where κ is the angle $C\,O\,G$."

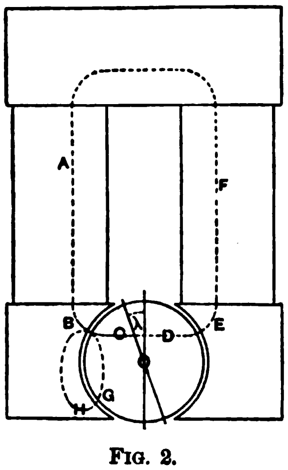

FIG. 2.

To verify this formula is one of the principal objects of this paper.

A pair of brushes having relatively fixed positions near together, and insulated from the frame and from one another, are carried upon a divided circle, and bear upon the commutator. The difference of potential between these brushes was measured in various positions round the commutator, the current in the armature, the potential difference of the main brushes, and the speed of the machine being also noted.

The results are given in Figs. 3, 4, 5 and 6, in which the ordinates are measured potential differences, and the abscissæ are angles turned through by the exploring brushes. The potential differences in Fig. 3 were measured by a Siemens voltmeter, and each ordinate is, therefore, somewhat smaller than the true value, owing to the time during which the exploring brushes were not actually in contact with the commutator segments. But this does not affect the results, because the area is reduced in the same proportion as the potential differences. In Figs. 4, 5, and 6 the potential differences were taken on one of Sir William Thomson's quadrant electrometers, and are correct.

Take Fig. 3, in which machine No. 1 is a generator. A centimetre horizontally represents 10 degrees of lead, and the ordinates represent differences of potential between the brushes. The area of the curve is 61.3 sq. cm., and represents 130 volts and a total field of $\frac{130}{104} \times \frac{1}{29} \times 10^8 = 4.31 \times 10^6$ lines of induction. This is, of course, not the actual field, which is 3 per cent. greater on account of the resistance of the armature, but is represented by an area 3 per cent. greater.

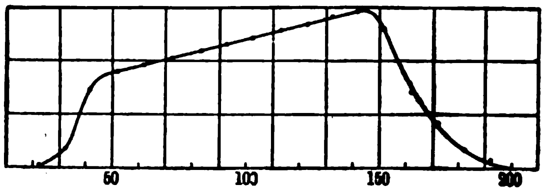

FIG. 3.

An ordinate of 1 cm. will represent an induction of $\frac{4.31}{61.3} \times 10^6 = 7.0 \times 10^4$ lines in 10 degrees. The area of 10 degrees is $39.5 \times 1.73 = 68.3$ sq. cm.[2] Hence, an ordinate of 1 cm. represents an induction of 1,024 lines per square centimetre. The difference between ordinates at 50 degrees and 140 degrees is 2.5; hence the difference of induction is actually 2,560. Theoretically, we have $\kappa = \frac{1}{2} = \pi\ m = 104\ C = 9.4$. Therefore, $2\,\kappa\,m\,C = 3{,}072$, and this is the line integral of magnetizing force round curve.

Let A be the induction at 50 degrees, and $A + \delta$ at 140 degrees; these also are the magnetizing forces. Hence, $(A + \delta)\,1.4 - A\,1.4 = 2\,\kappa\,m\,C$; $\delta = 2{,}200$ as against 2,560 actually observed.

Take Fig. 4, in which No. 2 machine is a motor. The total field $= \frac{107}{104} \times \frac{1}{20} \times 10^8 = 5.15 \times 10^6$ lines of induction. Since the area of the diagram is 53.5 sq. cm., an ordinate of 1 cm. $= \frac{5.15}{53.5} \times 10^6 = 96 \times 10^4$ lines of induction in 10 degrees. Hence, an ordinate of 1 cm. represents an induction of $\frac{9.6 \times 10^4}{68.3} = 1{,}400$ lines per sq. cm. The difference between ordinates at 320 degrees and at 230 degrees is 2.0; hence, the difference of induction is actually 2,800. Theoretically we have $\frac{2\,\kappa\,m\,C}{l} = \frac{3\frac{1}{7} \times 104 \times 11.4}{1.4} = 2{,}666$, as against 2,800 actually observed.

In Fig. 5 No. 1 machine is a generator. The total field $= \frac{52}{104} \times \frac{1}{12.6} \times 10^8 = 3.97 \times 10^6$ lines. The area of the diagram is 90.9 sq. cm., and therefore an ordinate of 1 cm. $= \frac{3.97}{90.9} \times 10^6 = 4.37 \times 10^4$ lines in 10 degrees. Hence, an ordinate of 1 cm. represents an induction of $\frac{4.37 \times 10^4}{68.3} = 639$ lines per sq. cm. The difference between ordinates at 50 degrees and at 140 degrees is 4.5; hence, the difference of induction is actually 2,877. Theoretically, we have $\frac{2\,\kappa\,m\,C}{l} = \frac{3\frac{1}{7} \times 104 \times 12.9}{1.4} = 3{,}010$, as against 2,877.

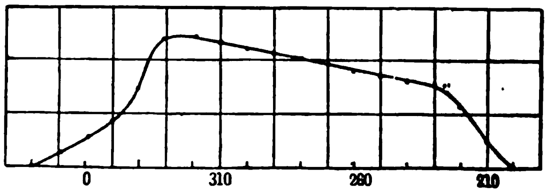

FIG. 4.

In Fig. 6, No. 2 machine is a motor. The total field $= \frac{63.5}{104} \times$

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[1] Abstract of paper read before the Royal Society.

[2] In calculating this area, the allowance for fringe at ends of armature is taken less than before, because the form of opposing faces differs.

$\frac{1}{12.8} \times 10^6 = 4.96 \times 10.6^6$ lines. The area of the diagram 112.2 sq. cm., and therefore an ordinate of 1 cm. $= \frac{4.96}{112.2} \times 10^6 = 4.42 \times 10^4$ lines in 10 degrees. Hence, an ordinate of 1 cm. represents an induction of $\frac{4.42}{68.3} \times 10^4 = 647$ lines per sq. cm. The difference between ordinates at 323 degrees and at 238 degrees is 4.2; hence, the difference of induction is actually 2,718. Theoretically, we have $\frac{2\,k\,m\,C}{l} = \frac{3\frac{1}{4} \times 104 \times 12.3}{1.4} = 2{,}870$, as against 2,718 actually observed.

At page 345 of the paper on Dynamo-Electric Machinery it is shown that

$$I + \frac{\nu - 1}{\nu}\, 4\,\lambda\, m\, C \frac{A_2}{2\, l_2} = F\left(4\,\pi\, n\, c - \frac{4\,\lambda\, m\, C}{\nu}\right),$$

where $I = F(4\,\pi\, n\, c)$ is the characteristic curve when $C = 0$, and λ is the lead of the brushes.

The following is an endeavor to verify this formula. The potentials both upon the magnets and upon the brushes were taken by a Siemens voltmeter, and are rough. The speeds were taken by a Buss tachometer, and there is some uncertainty about the precise lead of the brushes, owing to the difficulty in determining the precise position of the symmetrical position between the fields, and also to the width of the contacts on the commutator.

It was necessary in order to obtain a marked effect of the armature reaction, that the magnet field should be comparatively small, that the current in the armature should be large, and the leads of the brushes should be large.

The two machines had their axles coupled so that No. 1 could be run as a generator, and No. 2 as a motor. The magnets were in each case coupled parallel, and excited by a battery each through an adjustable resistance. The two armatures were coupled in series with another battery, and the following observations were made:

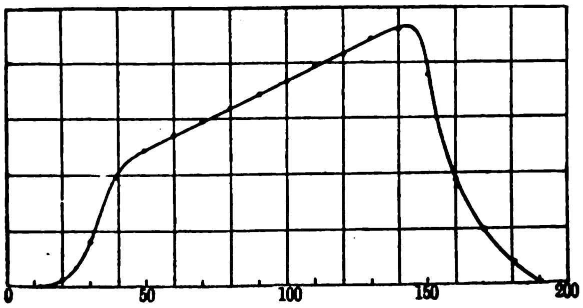


FIG. 5.

—	Potential on magnets in volts.	Potential on brushes.	Speed per minute.	Current in amperes.	Lead of brushes.
No. 1	24—24	66—67	880	102—103	26°
No. 2	29—29	86—84	880	102—103	29°

As there was uncertainty as to the precise accuracy of the measurements of potential, it appeared best to remeasure the potentials with no current through the armature with the Siemens voltmeter placed as in the last experiment. Each machine was, therefore, run on open circuit with its magnets excited, and its potential was measured.

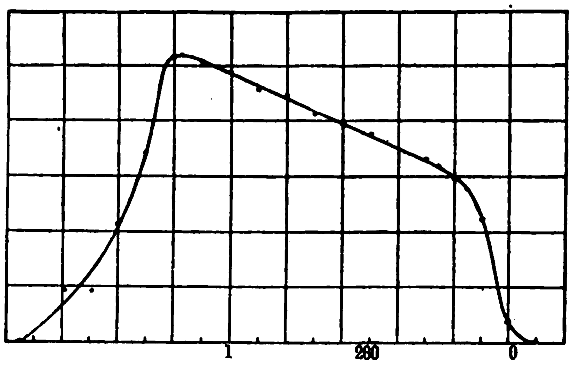


FIG. 6.

—	Potential on magnets in volts.	Potential on brushes.	Speed per minute.	Potential at 880 revs.
No. 1.	25—25	90.90	880	90.0
No. 2.	28—28	79.80	715—710	98.2

From which we infer, that we are upon a part of the characteristic which is practically straight; in which case, of course, the formula is reduced very nearly to

$$I = \frac{A_2}{2\, l_2}\,(4\,\pi\, n\, c - 4\,\lambda\, m\, C).$$

—	Potential on magnets.	Potential on brushes.	Induction $I = F(4\,\pi\, n\, c)$.
No. 1	24	86.4	2.82×10^6
No. 2	29	101.7	3.30×10^6

We have further:

$\lambda = 0.45$ for No. 1. $\lambda = 0.5$ for No. 2

$$\frac{4\, m\, C}{\nu} = 2{,}920 \qquad \frac{\nu - 1}{\nu}\, 4\, m\, C \frac{A_2}{2 l_2} = 443{,}800.$$

It has already appeared that experiment gives for I in No. 1 2.3×10^6, and in No. 2, 2.65×10^6. The difference is probably due to error in estimating the lead of the brushes, which is difficult, owing to uncertainty in the position of the neutral line on open circuit.

—	$\frac{4\,\lambda\, m\, C}{}$.	$\frac{\nu - 1}{\nu}\, 4\,\lambda\, m\, C \frac{A_2}{2\, l_2}$.	$4\,\pi\, n\, c - \frac{4\,\lambda\, m\, C}{\nu}$.	$F\left(4\,\pi\, n\, c - \frac{4\,\lambda\, m\, C}{\nu}\right)$.	$F\left(4\,\pi\, n\, c - \frac{4\,\lambda\, m\, C}{\nu}\right) - \frac{\nu - 1}{\nu}\, 4\,\lambda\, m\, C \frac{A_2}{2\, l_2}$.
No. 1 ..	1314	199700	7586	2.41×10^6	2.21×10^6
No. 2 ..	1460	221900	9290	2.90×10^6	2.68×10^6

From which we infer:

—	Currents in magnets.	$4\,\pi\, n\, c$	Corrected potential for resistance of armature.	Total induction I.
No. 1	1.78	8,900	70.8	2.30×10^6
No. 2	2.15	10,750	80.7	2.65×10^6

ELECTRIC LAUNCHES IN ENGLAND.

THE specially built electric launch constructed by Messrs. Woodhouse & Rawson, United, Limited, at their Chiswick Works to the order of the Southport Corporation, for use on their artificial lake was running during the Easter holidays with remarkable success. This boat, "The Bonnie Southport," will seat 40 persons, is 38 feet 5 inches long, has 7 feet 6 inches beam, and draws about 2 feet 3 inches of water. She is carvel built of bright mahogany, with a large counter, and is propelled by a 5 h. p. "W. & R." motor.

Reports of Companies.

OFFICERS FOR THE GENERAL ELECTRIC CO.

THE new General Electric Co. which is composed of the Edison General and Thomson-Houston Electric companies, elected its officers last Wednesday.

C. A. Coffin was elected president; Eugene Griffin, first vice-president, and Samuel Insull, second vice-president. A. S. Beves was made treasurer and assistant secretary; E. J. Garfield, secretary; J. P. Ord, comptroller; E. Clark, auditor, and B. F. Peach, Jr., and W. F. Pope, assistant treasurers.

The directors elected were: J. Pierpont Morgan, C. A. Coffin, Thomas A. Edison, D. O. Mills, F. L. Ames, T. Jefferson Coolidge, Eugene Griffin, Henry L. Higginson, H. McK. Twombly, C. H. Coster, and F. S. Hastings. Mr. Twombly was made chairman of the board.

It is possible that changes may occur later on in the constitution of the directory. For instance, it is understood that Mr. Hastings is leaving for Chicago, where he will be permanently connected with some very large interests there outside of the electrical field.

Reports have been current as to the intention to consolidate all the Canadian interests of the two companies under a large new company; and it is also rumored that one or two departments of the existing business may be turned over to new companies to be run independently under separate and distinct management.

A report has been current during the last few days that arrangements have been made by which the Edison General Electric Co., will, in all probability, give up the manufacture of electric and gas fixtures. It is also rumored that their large fixture business including the Avenue B factory property has been disposed of to a company or syndicate of capitalists, and that Mr. Samuel Insull will take the presidency of the new concern. This is important news, if true, and there seems no good reason for doubting its accuracy.

Patent Notes.

THE EDISON CARBON TRANSMITTER PATENTS.

As announced in our editorial columns last week, the Patent Office on May 3, granted to Mr. Edison several patents relating to the art of telephony, one of which is of more than usual importance on account of the scope of its claims relating to the use of plumbago or carbon in telephone transmitters. We give below an abstract of this patent upon which we comment elsewhere in this issue.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y.

Speaking-Telegraph.

Specification forming part of Letters Patent No. 474,231, dated May 3, 1892.

Application filed July 20, 1877. (Model.) Patented in England July 30, 1877, No. 2,909; in Canada October 20, 1877, No. 8,026; in France December 19, 1877, No. 121,687; in Belgium January 11, 1878, No. 43,984; in Austria-Hungary January 15, 187 ; in Italy January 19, 1878. No. 9,791; in Germany January 23, 1878, No. 14,308; in Spain May 6, 1878, and in Russia February 15-27, 1882, No. 1,161.

To all whom it may concern.

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an Improvement in Speaking-Telegraphs, (for which I have obtained foreign patents in the following countries: in Great Britain, dated July 30, 1877, No. 2,909; in France, dated December 19, 1877, No. 121,687; in Belgium, dated January 11, 1878, No. 43,984; in Italy, dated January 19, 1878, No. 9,791; in Spain, dated May 6, 1878; in Austria-Hungary, dated January 15, 1878; in Germany, dated January 23, 1878, No. 14,308; in Russia, dated February 15-27, 1882, No. 1,161, and in Canada, dated October 20, 1877, No. 8,026.) of which the following is a specification.

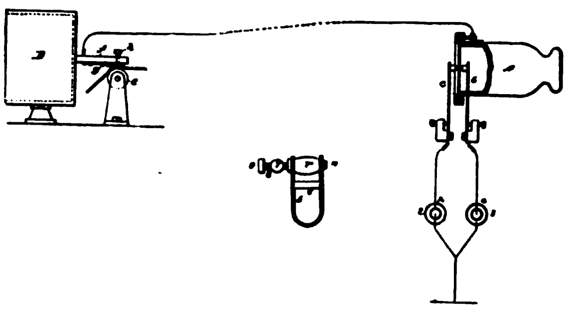
The object of this invention is to transmit the human voice over telegraphic wires for conversational purposes.

The invention consists in the use, in the circuit of a speaking-telegraph transmitter, of one or more contact-points formed of semi-conductors, such as plumbago, peroxide of lead, and other oxides and conducting material.

Fig. 1 shows the transmitter and receiver. A is the resonant chamber, over the end of which the diaphragm is stretched, either side of which may be made heavier in the center by a small weight if great amplitude is required of the diaphragm. *b c* are the two contact-springs, having points made of compressed plumbago, mixed, preferably, with gum-rubber; but any substance not liable to rapid decomposition may be used. These points face each other on the opposite side of the diaphragm and make contact with platina disks secured to the diaphragm. The spring *b* passes through a hole or small slot in the side of the transmitter. 2 and 3 are the main batteries The battery 2 has zinc to the line or point *c* and the battery 3 has copper to the line or spring *b*. When the springs *c* and *b* are adjusted so so as to make contact with the diaphragm equally, no current passes to the line; but when the diaphragm is vibrated its movement to one side—say *c*—causes a greater pressure upon the plumbago on that spring and a lessening of the pressure on the plumbago on *b*. Hence the balance of the batteries 2 and 3 will be destroyed. 2 being given the advantage will send a negative current to line. Upon the return of the diaphragm the battery-currents will again neutralize each other. The vibration of the diaphragm to the other side causes the pressure to be reversed and the battery 3 will send a positive current to the line. As plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak.

In Fig. 2 is shown the contact-spring, which I prefer to use instead of *c* and *b*, which are used merely to assist in explaining the operations more clearly. 5 is a U-shaped spring secured to the screw 8, which is adjusted back and forward by the thumb-nut 9. 7 is the pillar holding such screws. *r* is a piece of soft rubber or equivalent substance placed between the prongs of the spring 5. 6 is a wire or band, which serves to bind the prongs tightly against the rubber *r*, so as to prevent the prongs acting as a tuning-fork and transmitting harmonic vibrations not desirable. 10 is the plumbago contact-point. The object of the U-spring and rubber is to present a semi-rigid point for contact, so as to prevent a rebound and allow of a slight yield when the plumbago is pressed by the diaphragm. D is the receiver, which consists of a resonant chamber of any suitable character, either a tube, or as a box, as at D, Fig. 1. *f* is a rigid arm secured to the box and is provided upon its extreme end with an adjusting-screw *h*. Near the end of the arm is secured a spring *g*, whose end rests upon the chemically-prepared paper upon the drum *e*. The under side resting upon the paper is platinized. The screw *h* serves to increase and decrease the pressure of the platina spring upon the paper. When the paper is moved slowly by rotating the drum *e*, the waves of electricity coming over the line pass through the arm *f* to the platinized spring *g*; thence through the paper to the earth. If a negative current passes in the opposite direction, nearly all friction between the platina plate and the paper ceases and the resonant box or diaphragm regains its normal position. When the positive current passes through the same channel, the normal friction of the paper is augmented and the chemical surface, acting upon the platina, serves to give a movement to the resonant box. Thus the mechanical force applied to move the chemical surface acts with the electric current to produce the vibration of the resonant chamber. The principle of this method of obtaining motion by electro-chemical decomposition is described in my Letters Patent No. 158,787, granted January 19, 1875. To facilitate the discharge of electricity from the receiving apparatus, it may be shunted with an electromagnet.

The mouth of the speaking-tube may be closed except a horizontal slot, through which the vibrations of the voice pass to the diaphragm or tympan, the object of the slot being to increase the power of the hissing consonants; also, the point *b* may be dispensed with on very short lines.



FIGS. 1 AND 2.

In this specification no claim is made to the use of a spring for carrying one of the electrodes, since that invention forms the subject-matter of an application, Serial No. 192,456, filed as a division hereof.

I claim as my invention—

In a telegraphic apparatus operated by sound, the combination, with the diaphragm, of one or more contact-points of plumbago or similarly inferior conductor in the electric circuit, whereby the rise and fall of electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm, substantially as set forth.

Signed by me this 9th day of July, A. D., 1877.

THOMAS A. EDISON.

In addition to the above patent there were also issued to Mr. Edison two others, Nos. 474,230 and 474,232, relating to the method of suspending and attaching the plumbago to the diaphragm so as to obtain a yielding pressure.

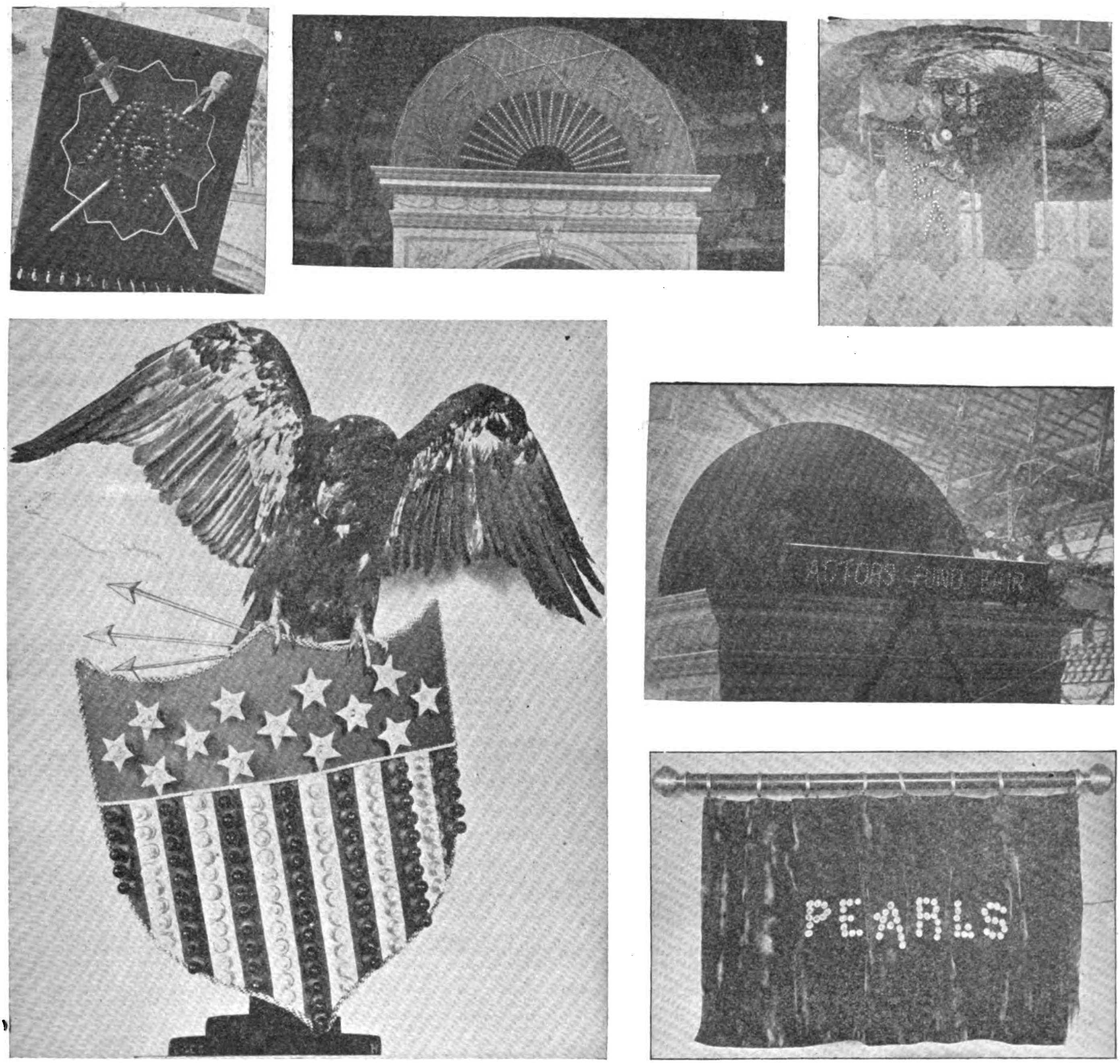
ENGINEERING EQUIPMENT COMPANY.

SOME of the recent and more important of the numerous sales of the Engineering Equipment Company, 143 Liberty street, New York, comprise line materials, poles, wire, trolleys, etc., for the several roads in the following cities: Pittsburgh, Savannah, Newark, Paterson, and Trenton, N. J., Rochester, Brooklyn, New York, Hamilton, Ohio, Chattanooga, Tenn., Elmira, N. Y., Lebanon, Pa., Johnson City, Tenn., Watertown, N. Y., San Antonio, Texas, Augusta, Ga., Colorado Springs, Hampton, Va., Cape May, N. J., Scranton, Pa., Washington, D. C., Syracuse, Buffalo, N. Y., Philadelphia, and several smaller cities in the Eastern, Middle and Southern States. The April business of the company was excellent.

The Engineering Equipment Company is pushing two of the best-known lines of railway insulating materials on the market—the Anderson "Aetna" and "G. & W." molded mica—both of which are noted for their durability and electrical and mechanical features. They are continually being improved to meet the demands of the most advanced practice. The Engineering Equipment Company has also just issued a circular, illustrating the Syracuse tubular iron poles and a variety of insulated and uninsulated tops and fittings, with a complete description of the pole, the standard sizes, weights and other data. The circular also contains some timely remarks on pole line construction by Mr. W. F. D. Crane, who has charge of the company's railway department, which will undoubtedly prove interesting and profitable to railway managers and engineers. Mr. Crane has recently contributed a portion of these practical observations to our columns.

EFFECTS WITH SMALL LAMPS AT THE ACTORS' FUND FAIR.

DURING the whole of last week, the Madison Square Gardens were occupied by a Fair, in aid of the Actors' Fund. The centre of the vast amphitheatre was filled by a number of booths chiefly in the form of reproductions on a large scale of such places as Shakespeare's house, the Globe Theatre, the Duke's Theatre, the Old Curiosity Shops, Thorne's Chatham Theatre, etc. The entrance to the arena was through a fine Roman arch and colonnade. All of these buildings were beautifully lighted by electricity, the work being done specially by the local Edison Illuminating Co., who made a very happy use of the new small lamps of the Edison General Electric Co. In many places the lamps were fastened under green bushes or in plumes of pampas grass, as well as in the more conventional brackets, sconces, etc. These 1,000 lights, added to the ordinary lights marking the lines of the dome and around the arena made the scene a veritable fairyland.



DECORATIVE ELECTRIC LIGHT EFFECTS WITH SMALL LAMPS AT THE ACTORS' FUND FAIR.

Besides these general effects; several ambitious pieces were worked out with brilliant success, and some idea of the scope of the whole display may be formed from the statement that over 10,000 lamps in the miniature sizes from 1 to 10 c. p. were used. There were 22 special designs, the largest being in the shape of a fan mounted on the entablature of the Roman arch. In this, by manipulation of a switch, the fan was made apparently to open and close every few minutes. Every shade and hue of the ornamentation was brought out clearly by the use of colored lamps. Another fine design was a U. S. shield, with each star a lamp with a three-pointed ground-glass bulb. In the centre of the dome hung a beautiful umbrella electrolier, with long pendant fringes illuminated by the lamps within. There was also a fine pinwheel, a very clever Japanese "Tea" design, an "A. O. of F." sign, two or three stars and the name of Edison. During the evening a large sign of white lamps announced that the service was given by the Edison light, but later on the reading became "Good Night." Altogether the results obtained were most gratifying to all who believe in the possibilities of small lamps. The beautiful towers at the Lenox Lyceum and at Minneapolis were a revelation of what could be done in that line; while the variety of design at the Actors' Fund Fair shows how readily the lamps lend themselves for structural effects. The Fair was visited by 15,000 or 20,000 people nightly, to all of whom the lighting was a source of infinite pleasure.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE following preliminary announcement of the programme for the annual meeting of the Institute has been issued by Mr. R. W. Pope, secretary:

The Annual Meeting of the Institute for the reception of yearly reports, the election of officers and other business of a similar character, will be held at the headquarters of the Institute, No. 12 West 31st street, at 4 p. m., Tuesday, May 17. It is expected that the session will occupy about two hours. After adjournment, those who desire to do so will assemble at "The Arena," 41 West 31st street, where a subscription dinner will be served, the price of which has been fixed at $2.00 per plate. This will be a purely social gathering, and it is hoped that all who can do so will be present.

The General Meeting will be held at the Grand Pacific Hotel, Chicago, on Monday, Tuesday and Wednesday, June 6, 7, and 8. The following papers are in preparation for that occasion and others are promised, which will be announced in the regular programme to be issued later.

1. "Electric Coal Mining Machinery," by Mr. Elmer A. Sperry, of Chicago.
2. "On the Electromagnetic Field," by M. I. Pupin, Ph. D., of Columbia College, New York City.
3. "Long-Distance Transmission for Lighting and Power," by Mr. Charles F. Scott, of Pittsburgh, Pa.
4. "A New Rheostat," by Mr. C. E. Carpenter, of Minneapolis, Minn.
5. "A Dynamo Indicator, or Instantaneous Curve Writing Voltmeter," by Prof. George S. Moler, of Cornell University, Ithaca, N. Y.
6. "Electro-Technical Education," by Prof. R. B. Owens, of the University of Nebraska, Lincoln, Neb.
7. "The Magnetic Properties of Sheet Iron," by Mr. Milton E. Thompson, of Cornell University, Ithaca, N. Y.
8. "Selective or Individual Signals," by Mr. Thomas D. Lockwood, of Boston, Mass.
9. "Railroad Train Lighting," by Mr. A. H. Bauer, of Chicago.
10. "A Discussion of Circuits Containing Resistance, Self-Induction and Capacity," by Messrs. Frederick Bedell and Albert C. Crehore, of Cornell University, Ithaca, N. Y.
11. "A Life and Efficiency Test of Incandescent Lamps," by Prof. B. F. Thomas and Messrs. P. Martin and R. H. Hassler, of the Ohio State University, Columbus, Ohio.
12. "Notes on Wiping Contact Methods for Current and Potential Measurement," by Prof. B. F. Thomas, of Columbus, Ohio.
13 "Series Electric Traction," by Mr. Nelson W. Perry, of New York City.
14. "Oil *vs.* Air as Insulation," by Dr. J. B. Williams, of New York City.
15. "On the Electrolytic Refining of Copper," by Lieut. F. B. Badt, of Chicago.
16. "The Photography of Alternating Current Curves," by Dr. Edward L. Nichols, of Cornell University, Ithaca, N. Y.
17. "The Reversal of Polarity in Plating Dynamos;" and also on
18. "Dynamos for Continuous Current Circuits," by Prof. Harris J. Ryan, of Cornell University, Ithaca, N. Y.
19. "The Technical Education of the Electrical Engineer," by Prof. D. C. Jackson, of the University of Wisconsin, Madison, Wis.

Papers are also expected from Mr. H. Ward Leonard, Prof. Elihu Thomson and Prof. Geo. D. Shepardson, the subjects of which cannot be announced at present.

The convention rate of transportation at one and one-third the regular fare for the round trip, can be secured in case the attendance is sufficiently large to comply with rules of the Central Traffic Association. Members will be informed subsequently whether such arrangements can be perfected.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED APRIL 26, 1892.

Accumulators:—

Secondary Battery, I. L. Roberts. Reissue 11,238. Filed Jan. 28, 1892.

Employs an electrolyte of a salt of iron capable of forming an acid radical, and a non-porous electrolytic diaphragm interposed between the electrodes.

Alarms and Signals:—

Electric Railway Signal, C. E. Corporan, 473,614. Filed June 17, 1891.

A signal for steam railways which will automatically apprise an engineer of the approach of another train on the same track from either direction.

Thermostatic Fire Alarm, G. D. Mosher, 473,669. Filed Dec. 21, 1891.

Electric Signal for Railway Trains, L. Dunn, 473,832. Filed Nov. 30, 1891.

Conductors, Conduits and Insulators:

Covered Electric Wire, H. A. Reuter, 473,713. Filed July 25, 1891.

A covering consisting of parchmentized fibre, helically wound.

Coupling for Electric Wires, J. F. McElroy, 473,637. Filed Nov. 24, 1891.

A coupling designed especially for use in connecting the lighting and signaling wires on railway trains.

Distribution:—

Electric Switchboard, J. B. Mayer, 473,848. Filed May 11, 1891.

Has for its object to secure a more compact arrangement of parts, and greater security against burning out terminals.

Dynamos and Motors:—

Dynamo-Electric Machine, W. Decker, 473,547. Filed Nov. 25, 1891.

An armature for multipolar machines in which but two wires are connected in multiple at a time.

Commutator Connection for Electric Motors or Generators, C. G. Curtis, 473,567. Filed Aug. 26, 1891.

A riveted connection with the commutator bars presenting a large surface of contact and also permitting of easy disconnection if necessary.

Armature for Dynamo-Electric Machines or Motors, C. G. Curtis, 473,568. Filed Nov. 12, 1891.

Claim 1 follows:

An armature enclosed in a waterproof covering, that part of the covering in the path of the lines of force being of non-conducting material, and rigid caps protecting the ends of the armature.

Dynamo-Electric Machine, R. Eickemeyer, 473,618. Filed June 18, 1888.

Comprises a winding composed of a set of detachable counterpart coils each having a keystone form and having but one side in immediate contact with the face of the armature drum.

Dynamo-Electric Machine, R. Eickemeyer, 473,619. Filed Dec. 28, 1889.

An armature winding consisting of two or more mechanically united but independent coils, each longer on one side than the other, each centrally at its ends being in the form of a curved, flat web, and all but one of them folded inwardly near one side, and thence extended tangentially.

Galvanic and Thermo-Electric Batteries:—

Plunge-Battery, J. H. Howard, 473,463. Filed Dec. 1, 1890.

Employs shafts journaled in the casing near its opposite ends to which the carbon and zinc plates are attached respectively.

Lamps and Appurtenances:—

Alternating Current Arc Lamp, B. B. Ward, 473,536. Filed March 28, 1891.

Employs a carbon-supporting lever in connection with an alternating current lamp-magnet having its movable core connected loosely to the former, and a damper of the vibrations applied between the core and the lever.

Combined Gas and Electric Light Bracket, J. Fitzgerald, 473,661. Filed July 14, 1891.

Measurement:—

Electrical Measuring Instrument, E. Weston, 473,538. Filed Jan. 8, 1891.

An indicating device having a scale plate of translucent material in order that it may be illuminated and rendered visible at a considerable distance.

Electrical Measuring Instrument, E. Weston, 473,539. Filed Jan. 24, 1891.

A measuring instrument serving to convert the rectilinear movement of an armature into rotary movement of a needle over a scale.

Miscellaneous:—

Induction-Discharge Protector for Welding Apparatus, H. Lemp, 473,514. Filed Aug. 14, 1889.

Employs two electrodes connected respectively to the terminals of the primary coil and separated by a very narrow space containing air or insulating material.

Electric-Circuit Controlling Device, M. Thum, 473,594. Filed June 5, 1891.

A device by which the normal amount of current in a circuit may be maintained within certain limits or by which a signal is given whenever the current rises above or falls below the normal limit.

Circuit-Controlling Device, M. Thum, 473,595. Filed June 5, 1891.

A magnetic core having an electric contact portion, a helix surrounding the core and connected with the contact, and an armature having the contact adapted to bear upon that first mentioned and to be separated therefrom upon the movement of the armature toward the core.

Automatic Heat-Regulating Apparatus, C. F. Goodhue, 473,699. Filed May 29, 1891.

Electric Contact Protector, R. Varley, Jr., 473,717. Filed July 7, 1891.

Employs one electrode passing through an elastic shield.

Claim 1 follows:

Two electrodes, one of which is recessed in line of the other, in combination with an elastic septum through which one electrode passes and which sets tightly against the raised surface of the other electrode.

Automatic Transporter and Exploder for Explosives for Aiding Rain-Fall, L. L. Brown, 473,820. Filed Jan. 5, 1892.

Manufacture of Carbon Blocks, L. Hulin, 473,841. Filed Apr. 23, 1890.

A carbon conductor consisting of a number of specially prepared carbon plates fitted together and baked.

Process of Obtaining Metals from their Ores or Compounds, C. S. Bradley, 473,866. Filed Feb. 23, 1883.

Consists in combining a blow-pipe flame with the heating action of the current.

Electrically-Propelled Vehicle, F. Gardner, 473,871. Filed Aug. 31, 1891.

An electric tricycle.

Railways and Appliances:—

Electric Locomotive, S. H. Short. 473,674. Filed May 26, 1891.

Has for its object to prevent sudden shocks and jars to motors mounted directly upon the axles of vehicles.

Electric Locomotive, J. I. Conklin, 473,693. Filed Mar. 4, 1891.

Employs a series of motors combined with the main wheel constituting a main power transmitting device.

Switches and Cut-Outs:—

Circuit-Closer, C. H. Delano, 473,499. Filed Sept. 16, 1891.

Consists of a body of conducting material having a tubular passage for conducting-wires; an interior series of flexible strips and a conducting plate insulated from the conducting material, and having the wires connected with it.

Electric Switch, H. K. Hitchcock, 473,504. Filed Sept. 16, 1891.

Comprises a number of contacts for the purpose of connection between a circuit and any one of a number of dynamos.

Telephones and Apparatus:—

Two-Wire Telephone System, G. Taintor, 473,532. Filed May 9, 1890.

Has for its object to enable any station to call "Central" should either of the wires become broken.

THE DETROIT ELECTRICAL WORKS SYSTEM FOR JACKSONVILLE, ILL.

WE have received the following interesting communication from the Detroit Electrical Works with regard to another contract they have just secured:

The Jacksonville Railway Co., Jacksonville, Ill., W. S. Hook, president; B. F. Sibert, superintendent; after carefully investigating the merits of the different street railway systems, on January 6, 1892, decided to divide their order for motor equipments between the Detroit Electrical Works and the Thomson-Houston Company, and gave each an order for three 30 h. p. equipments, their object being to ascertain for themselves the comparative merits of the two systems for their benefit in placing future orders. The road was equipped and put into operation about March 1, 1892. May 2, the Detroit Electrical Works received an order for three additional 30 h. p. motor equipments. As it was given after both systems were put into operation, it is a victory for the Detroit Works, and supports their claim that their railway equipments will compare with any other manufactured. The equipments furnished by the Detroit Works under the original contract were their standard double reduction. Those furnished by the Thomson-Houston Co. were their latest W. P.

MADDEN'S IMPROVED STORAGE BATTERY.

MR. A. F. MADDEN has retired from Messrs. Lloyd & Payton, Ltd., and is now at work upon a radical departure in storage battery work. Mr. Madden's new cell closely resembles the Planté in principle, but by its method of manufacture it overcomes the tedious process of formation required by the latter, and forms the active material at once in the shape best adapted for heavy work. Mr. Madden claims that his new cell is entirely outside the claims of the Brush or Faure patents.

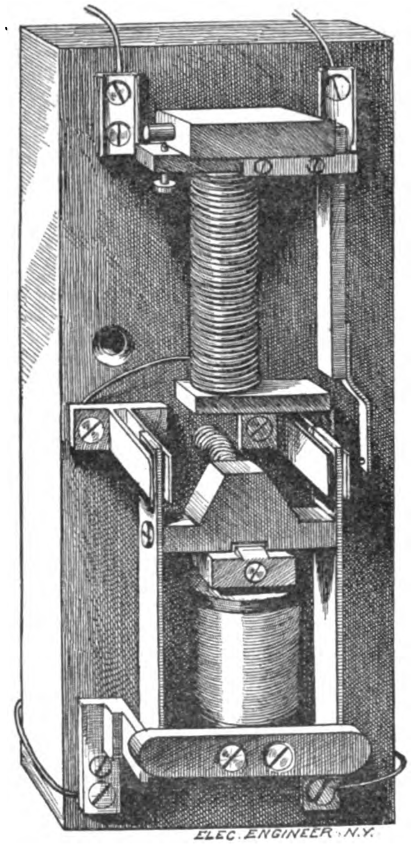
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Publicity and merit are the main supports of every successful business.

A NEW CUT-OUT OF THE INTERIOR CONDUIT CO.

This cut-out is designed to be placed in a circuit in a like manner to that in which a lead safety fuse is now connected.



New Cut-Out of The Interior Conduit Co.

It performs in all respects the functions of the ordinary fuse but with much greater accuracy. The instrument consists of a double-pole jack-knife switch, an adjustable relay for setting the cut-out at any load, and a knife resistance release magnet for opening the switch. The entire apparatus is mounted on a slate base with a glass-top mahogany cover, presenting a very neat appearance, besides being of very small size, namely 7½ x 3 inches.

The double-pole switch has a heavy spring tending to keep the switch open. The switch is kept closed by a catch attached to the armature of the release magnet. Placed above the switch is the relay wound with coarse wire which acts as an ammeter, the armature of which will close when energized by a sufficient amount of current, and makes a contact which completes a circuit through the release magnet. The armature of the latter being thereby attracted, the catch is removed and the switch flies open from the action of the heavy spring.

Supposing, for instance, the armature of the relay is adjusted so as just not to close when ten lamps, or whatever number it is set for, are in circuit. As soon as another lamp is added, the increased current will instantaneously cause the armature to close, when, the release magnet being energized, the switch immediately opens, both poles of the circuit being disconnected. Should it be attempted to close the switch while the overload is still on, the release magnet armature would instantaneously close and refuse to hold the switch down. Should a short-circuit take place, the action would be identically the same. One great advantage of the cut-out is its infallibility. Being once set to open at a certain current, it remains so, no matter how many times it is called into action.

It is as easy to apply as a safety fuse. The mains are connected to one side and the circuit to the other. It makes absolutely no difference to which end the mains are connected and to which end the circuit.

No other connections whatever are to be made, and the whole apparatus is self-contained. There will never be a chance of a three-light fuse carrying fifteen lights before fusing, as happens in many cases. If set for three lights it will always open when this number is increased. The device instantly commends itself to fire underwriters, insurance inspectors and all others who are interested in the continued progress made by the Interior Conduit and Insulation Co. or other concerns in the matter of properly safeguarding electrical conductors.

THE NEW WHITTINGHAM AUTOMATIC MOTOR STARTER.

The automatic switch, made by the Automatic Switch Co., of No. 8 Keyser Building, Baltimore, Md., has been eminently successful in connection with motors of the smaller horse powers when used by careful persons; but for the larger horse powers, and in general use, it has in some cases failed to work satisfactorily. The company has, therefore, for some time been experimenting with the object of eliminating the weaknesses of the automatic switch, and have now introduced the new Whittingham automatic motor starter, the operation of which will be readily understood by referring to the accompanying illustrations.

As will be seen, Fig. 1 is an exterior view of the device, while Fig. 2 is a diagram of the working mechanism. The solenoid magnet furnishes the power for operating the heavy contact bar which slides up over the resistance plates, and acts against the control of the dash-pot at the bottom of the starting box, thus making a gradual movement over each successive resistance plate.

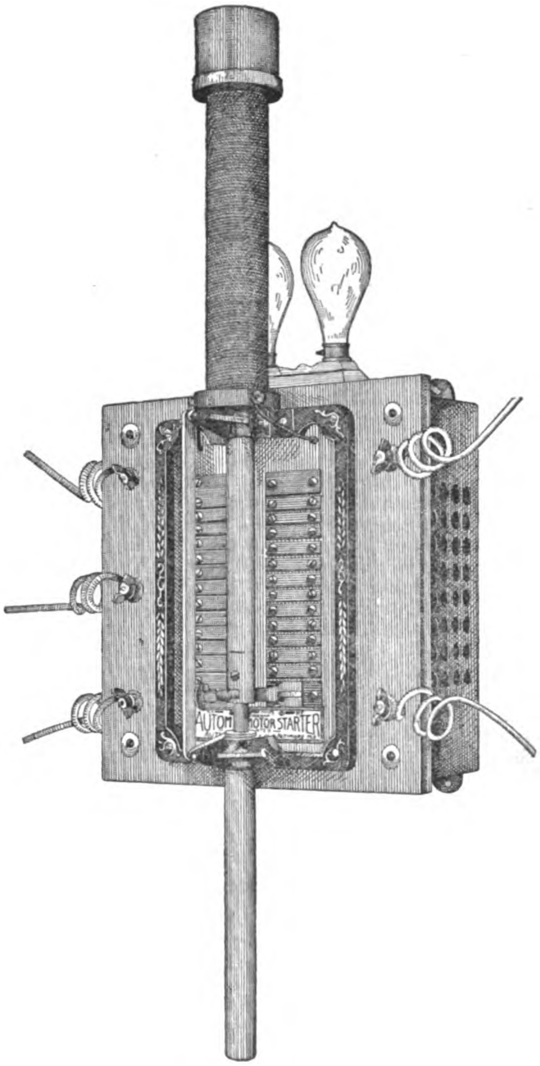


Fig. 1.—New Whittingham Automatic Motor Starter.

When the top contact is reached, the power of the magnet is automatically weakened, and only enough magnetism developed to hold the contact bar firmly in place. The energy consumed in the magnet when the bar is in its final position with the motor running, is only about forty watts. When the current is cut off, the magnetism ceases, and the contact bar falls to its original position at the bottom of the resistance plates, ready to start the motor again when the current is turned on.

The design is entirely new and the workmanship excellent. The box is fireproof, nothing but slate and metal being used in its construction, while the resistance blocks are of sufficient number to avoid any unsteadiness in starting. A double-pole switch is furnished with each starter. The two are entirely separate, however, and the former may be placed at any convenient point.

In elevator, pumping or other work of intermittent character, this automatic motor starter will be found of great service, since it is only necessary to arrange for the opening and closing of a simple switch.

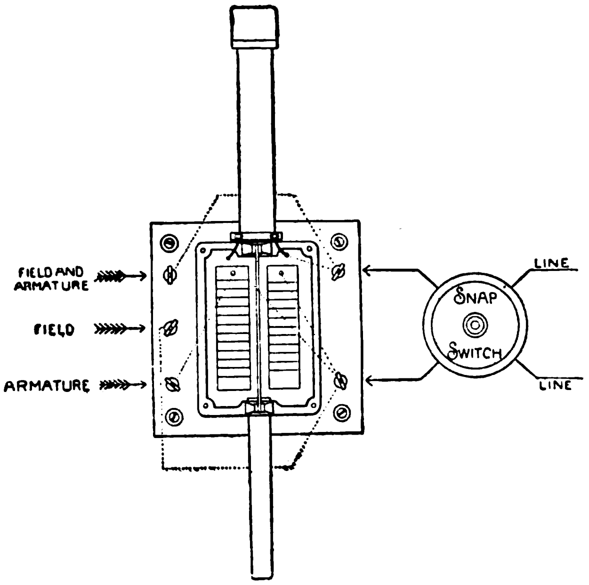


FIG. 2.—NEW WHITTINGHAM AUTOMATIC MOTOR STARTER.

ACTIVITY OF THE BALL & WOOD CO.

THE Ball & Wood Company ever since the shipment of their first Improved Ball high-speed engine in October last have been running twenty-four hours each day to keep up with their orders, and now have between twenty and thirty engines on the floor under construction, all contracted for. Important additions to their works are under contemplation. Among their recent shipments are the following: Two 300 h. p. cross-compound engines for the Brush Electric Co, Cleveland, Ohio; two 125 h. p. engines for the Yonkers Street Railway Co., Yonkers, N. Y.; one 100 h. p. engine for the Pennsylvania Railroad Co., of Baltimore, Md.; one 150 h. p. engine for the Tide Water Oil Co., Bayonne, N. J.; two 300 cross-compound engines for the Sauquoit Silk Manufacturing Co., Scranton, Pa.; one 300 h. p. cross-compound engine for the Edison Electric Illuminating Co., Paterson, N. J.; three 150 h. p. standard engines for the Edison Electric Illuminating Co., Paterson, N. J.; one 150 h. p. engine for the State House, Trenton, N. J.; one 100 h. p. engine for the Meriden Electric Light Co., Meriden, Conn.; two 80 h. p. engines for the Four Seasons' Hotel, Cumberland Gap, Tenn.; one 150 h. p. engine for the Laconia Car Co., Laconia, N. H.; two 150 h. p. engines for the Chicago Arc Light & Power Co., Chicago, Ill.; one 100 h. p. engine for Sulzer Brothers, Winterthur, Switzerland; one 60 h. p. engine for the U. S. Navy Yard, Brooklyn, N. Y.

A "SOUVENIR" OF BRUSH ISOLATED PLANTS.

THE BRUSH ELECTRIC Co., of Cleveland, has issued a sumptuous brochure, which contains a series of admirable illustrations and descriptions of six complete isolated incandescent plants which it has installed in so many of the largest and finest office buildings in the world, situate in Kansas City, Omaha, Minneapolis, St. Paul, Montreal and New York City. The text has been carefully compiled by Mr. Will. H. White and includes a detailed account of the new Brush incandescent machine. Not only are exterior and interior views given of the buildings, which are those of the New York Life Insurance Co., but there are a large number of views of the plants that light them. There also appear illustrated descriptions of the U. S. cruiser "Boston" and her plant, and of the Grand Hotel, Yokohama, and the Hotel Fuji, Japan. The book is a large quarto and comes from the press of the Matthews-Northrup Co. It has a richly illuminated cover fastened with silken cord.

NEW ENGLAND NOTES.

THE WEST END STREET RAILWAY COMPANY, of Boston, having found that the present 25-foot cars are too large for economical working during the light traffic hours, and too long for the faithful collection of fares when crowded, have decided to try 20-foot cars in future. The 25-foot cars are also very heavy and pound the rails very hard, and while they have been acknowledged to be a success as a convenient and easy riding car, it has been determined to try a car somewhat shorter. The West End Company are also busy preparing a number of four-wheel trucks of a new design for use on the 18-foot open summer cars. These trucks will most probably be equipped with single motors of 25 h. p.

THE JARVIS ENGINEERING COMPANY, of Boston, have secured the agency for New England of the American feed-water heater, manufactured by the Whitlock Pipe Coil Company, of Elmwood, Conn. This heater is the result of over 14 years' experience in the manufacture of various styles of feed-water heaters, and is constructed of one or more coils of the best seamless drawn copper tubing, incased by an iron shell with brass fittings. The heater is first-class in every respect, and possesses a number of advantageous features distinctly its own. Electrical engineers would do well to investigate its merits as early as possible.

THE WEST END STREET RAILWAY COMPANY, of Boston, have sent to the aldermen a copy of the report of the commission appointed by the company in the matter of electric car fenders, and called attention to the fact that the commission recommend the company to put on 50 of the pattern known in general as the "Cleveland fender," for trial. These fenders, Mr. Whitney states, were ordered at once, and, if they prove satisfactory, will be applied to the cars as soon as possible. The commission has not yet been discharged, as other experiments are being tried.

THE GOULD PACKING COMPANY, of East Cambridge, manufacturers of the famous Gould packing for steam engines, continue to do a good business, and are daily in receipt of orders from engineers for their goods. This packing is largely imitated and engineers would do well to send in their orders direct, or else to some thoroughly reliable supply house, as there are large quantities of so-called Gould packing on the market which never was manufactured at East Cambridge and which is of a very inferior quality.

THE BERLIN IRON BRIDGE COMPANY have received the contract for the new rolling-mill which the Waterbury Brass Company, of Waterbury, Conn., will build to replace the one lately destroyed by fire. It is said that this will be the finest rolling-mill in the Naugatuck Valley, being 150 feet in width by 350 feet in length, with brick side walls and iron roof trusses covered with the Berlin Bridge Company's patent anti-condensation corrugated iron roof covering. The building will be absolutely fireproof.

THE BROOKLINE GAS LIGHT COMPANY, of Brookline, held a reception at their new station on April 21st, under the auspices of the president and directors of the company, when an opportunity was afforded the visitors of thoroughly inspecting their new plant, recently described in these columns. About 200 guests were present, and were cordially received and shown through the many interesting departments of the works, after which a collation was served.

THE MASSACHUSETTS ELECTRICAL ENGINEERS' AND MECHANICS' ASSOCIATION held their third anniversary of their establishment, last Tuesday, the 26th of April, at the Association's headquarters, No. 3 Boylston Place, Boston. Dinner was served, after which an address was made by the president of the organization. Among the invited guests were Inspector of Wires B. S. Flanders, Deputy Inspector William Godfrey, Prof. Gilley and E. A. Bicknell.

THE VAN DEPOELE MEMORIAL ASSOCIATION has recently had its first annual dinner to honor the memory of C. J. Van Depoele.

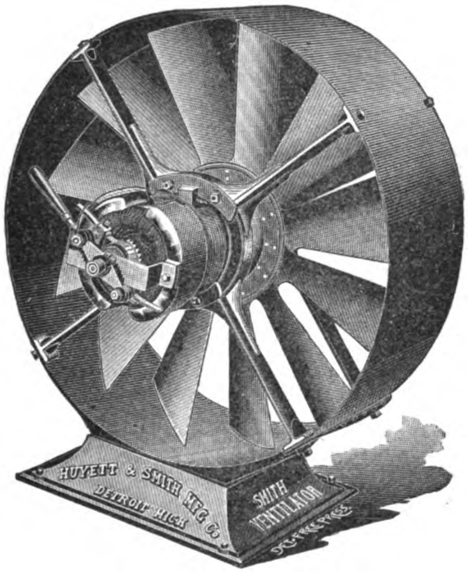
PHILADELPHIA NOTES.

THE WEST END ELECTRIC CO., although not a year in existence, have recently made several additions to their plant at Thirty-first street and Girard avenue. Their present capacity is five 50-light Thomson-Houston arc dynamos, two 1,300 and one 650-light Thomson-Houston alternating dynamos. Mr. A. J. Martin, their superintendent, says that the Bishop cables which are used throughout the plant show an average insulation of 200 megohms per mile with transformers connected, and have not given the slightest trouble.

MR. L. F. RONDINELLA, electrical, mechanical and civil engineer, has opened an office at 705 Chestnut street, where he will conduct the business of his profession. Mr. Rondinella is well known among the electrical fraternity, having been a professor at the Central Manual Training High School for several years and has taken a lively interest in electrical and other scientific matters at the Electrical Section of the Franklin Institute, where he acts in the capacity of secretary and treasurer.

THE HUYETT & SMITH ELECTRIC VENTILATING FAN.

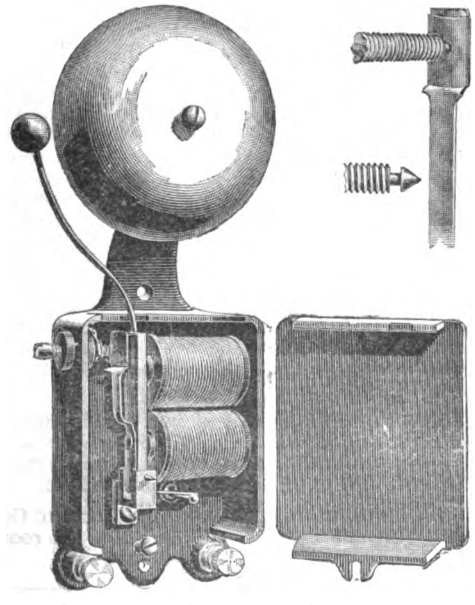
We illustrate on this page a very compact and efficient ventilating fan which has recently been brought out by the Huyett & Smith Manufacturing Co. of Detroit, Mich. As will be seen from the illustration the motor is snugly carried by a spider and on the same axle as the fan itself. There is thus practically but one moving part, and the motor by being thus centered does not obstruct the process of ventilation. The circular form of the motor gives a very strong magnetic field as well as secures economy of weight and space. The motors are so wound as to require no external resistances etc., and the simple switch by increasing or lessening the speed governs the amount of air that is delivered. The motors run quite noiselessly and are free from sparking at the commutator. They are built in various sizes and will furnish according to their size from 6,000 to 40,000 cubic feet of air per minute at normal speed. The whole is neatly mounted on a strong base and can be quickly set up.


HUYETT & SMITH MFG. Co.
DETROIT MICH.
SMITH VENTILATOR

Huyett & Smith Electric Ventilating Fan.

J. JONES & SON'S ANTI-DUST BELL.

The above company, located at 602 West 22d street, New York, have recently placed on the market a bell which is as much protected from dust as any ever shown. Besides this, the make-and-break apparatus is further protected, as will be seen by the cut herewith. The contact points are enclosed in rubber so that not a particle of dust may enter. This makes a very clean contact and one that, with the perfect points used, will practically last forever. When once the bell is placed and the cover attached, there is no reason why it should ever be opened. A device for regulating the contact is placed outside the box.

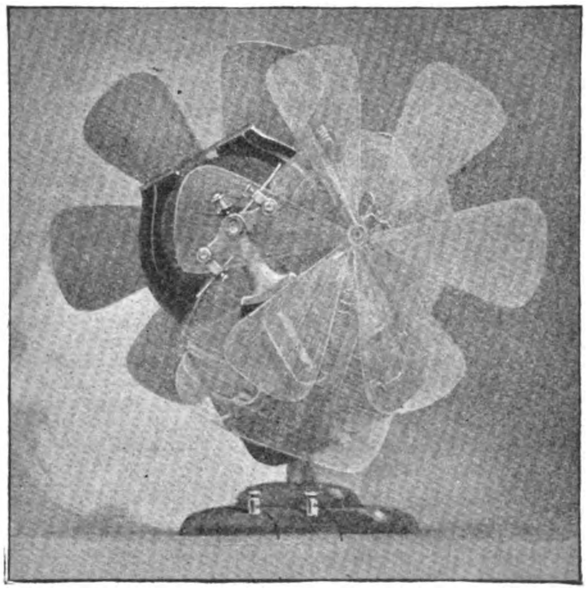


J. Jones & Son's Anti-Dust Bell.

THE CROCKER-WHEELER PIVOTED FAN MOTOR.

Those who during the past summers have enjoyed the artificial breeze stirred up by an electric fan outfit, and the better ventilation which results therefrom, will thoroughly appreciate the merits of this recent product of the Crocker-Wheeler Electric Company, New York. The illustration almost explains itself.

The pivoted fan motor is mounted upon an ornamental base of dark-red wood and swings slowly around the circle upon a pivot, throwing the breeze to every corner and part of the room. It will be readily understood that the ventilation is therefore complete, while the motion imparted to the atmosphere more closely resembles the cooling breezes of nature than the steady blast from a stationary fan. The pivoted fan motor is equipped with the Crocker-Wheeler variable speed switch, thus giving either a gentle zephyr or a strong breeze, as may be desired. These outfits are furnished, $\frac{1}{12}$ h. p., 115 volts, and $\frac{1}{6}$ h. p., 115, 230 or 500 volts, with self-oiling bearings. The $\frac{1}{6}$ h. p. 500-volt motor has only one speed.



Crocker-Wheeler Pivoted Fan Motor.

RAILWAY WORK IN OHIO.

The East Liverpool and Wellsville Electric Railway, which was completed last December, exactly three months from the day ground was first broken, is one of the most successful ever installed, and the company have already found it necessary to double the equipment. The J. G. Brill Company are just completing eight fine open cars, for which the Short Electric Railway Company of Cleveland, Ohio, will furnish 16 20 h. p. single-reduction motors and two additional 133 h. p. generators, and Messrs. E. H. Jones & Co., of Cleveland, who put in the first steam plant, are also doubling their part of the equipment.

A number of persons interested in the Cable Railway Company have recently secured franchises for an electric railway in Fort Wayne, Ind., to be called the "Fort Wayne Electric R. R. Co." The order for the equipment has been placed by Robison Bros. with the Short Electric Railway Company. It consists of the following apparatus: 32 car equipments complete, comprising 64 20 h. p. single reduction Short motors and 10 miles of overhead construction. Shipment of apparatus is already begun, and from the vigorous manner in which the Robisons are pushing the construction work, it is expected that the road will be completed and in operation by the 1st of June.

Fitch Battery and Electric Co.—This company, in mentioning that its "Perfect" battery is always clean, has a low internal resistance, has a constant E. M. F., is slow to polarize and quick to recuperate,—calls attention to its "Perfect Battery Excitant," which they furnish for all cells using carbon and zinc with sal ammoniac. This excitant is designed to supersede sal ammoniac; and a trial package costs so little that it would seem that at least an experiment would be in order by battery users.

PHILADELPHIA NOTES.

Mr. George Weston, of W. H. Weston & Co., switch manufacturers, met with a severe accident last week while operating a milling machine. The sleeve of his left arm became entangled with the metal saw which while in motion drew his arm through the machine, causing a painful wound that will disable him for several weeks.

Mr. Thomas Spencer, formerly chief electrician for the North American Construction Co., of Pittsburgh, Pa., has accepted a position as electrical and mechanical engineer for the Star Electrix Co., of this city. Mr. Spencer is widely known in both England and this country as a consulting electrical engineer.

In Partrick & Carter Co.'s advertisement this week will be found an illustration of their patent needle annunciator for house use. The firm's catalogue shows many styles of cases in which they make this annunciator and a copy should be in the hands of the trade everywhere.

Vallee Bros. & Co. have been appointed sole agents for Philadelphia and vicinity for the well-known Paiste switches and "K. W." cut-outs now manufactured by the Bryant Electric Co., Bridgeport, Conn.

The La Roche Electric Works are very busy just at present. They have contracts on hand to equip three central stations and nine isolated plants in various parts of the country.

The Star Electrix Co. are contracting with outside parties to make electrical supplies in addition to the manufacturing of their specialties.

A. J. **Martin** and Edward R. Grier have been appointed special agents to collect statistics of electrical industries in Philadelphia.

Mr. Arthur L. Bosley has resigned his position as president and manager of the Pennsylvania Electric Engineering Co.

WESTERN NOTES.

The Minneapolis Street Railway Company's new power house will be equipped with ten 300 h. p. Westinghouse engines running ten Thomson-Houston generators of equal power. The engines are compound, with cylinders 16 and 27 inches in diameter and 16-inch stroke. Each engine is connected to its dynamo by a 24-inch leather belt running from an 82-inch pulley on the engine to a 36-inch pulley on the dynamo. This plant will be 3,000 h. p. grouped in a space 87 feet by 73. The boiler-room will occupy an equal area, and will contain seven Sterling high pressure water-tube boilers, with a capacity of 287 h. p. each. The fuel will be crude oil, pumped from tanks as needed. Water will be supplied from an artesian well, which is now drilled to a depth of 575 feet.

Heine Safety Boiler Co.—We are in receipt from the Heine Safety Boiler Co., of St. Louis, of a circular presenting a record of two comparative tests between their boilers and those of the Babcock & Wilcox Co., admitting defeat in one trial and claiming a decisive victory in the other. The case is presented with considerable pressure of steam, and forms an interesting addition to one of the most important techincal controversies of the year. We are not buying boilers ourselves, but a good many of our readers are, and for such this kind of reading must have no small charm, affecting the pocketbook very closely and deeply as it does.

The Great Western Electric Supply Co. have recently largely increased their facilities and have taken the entire second floor of the Springer Building to meet the requirements of their growing trade. They have fitted up an exceedingly handsome show-room and extensive suite of offices adjoining. This new departure is in line with the progressive policy of the company, who are now doing a very large amount of manufacturing of their own goods and have equipped their extensive factory with all the latest and most approved tools for their special line of work.

The Electric Appliance Company report several very large orders for swinging ball lightning arresters. They have furnished a complete equipment of these valuable devices to a number of the largest plants in the Western country. Station managers generally are beginning to realize that lightning arresters are as necessary as insurance on their plants, and the swinging ball lightning arrester is filling the demand for an instrument that can be put up once for all and afterwards be depended upon to be there and do its work without further attention.

Rodolphus Fuller, electrical and mechanical engineer and supt. Fontaine Crossing Co., Detroit, Mich., was a caller at the Western office of The Electrical Engineer last week. Mr. R. Fuller is supervising the putting in of a number of the Fontaine railroad crossings on the Chicago and Northern Pacific R. R. here.

Mr. F. J. Pearson, electrical engineer and expert, of Kearney, Neb., is desirous of representing a few Eastern electrical companies in his part of the country. Mr. Pearson's wide practical experience in electrical work and electricity will be of especial value to him in the commercial field.

Mr. H. W. Gilman, general manager of the Great Western Electric Supply Co., recently returned from a business trip East, on which he secured a number of large orders for general electrical supplies and the various specialties manufactured by the company. The Great Western Electric Supply Co. will shortly issue a very complete and handsome catalogue of their house goods. They report that they are exceedingly busy in the manufacturing of arc lamps for incandescent circuits and are now some 200 lamps behind with their orders, but with their recently increased facilities will very soon catch up. They state that their Sun arc lamps are giving very general satisfaction, and that repeat orders are numerous.

Mr. J. R. Burdick, traveling representative for the H. W. Johns Manufacturing Company, was a caller at the Western office of The Electrical Engineer last week and was accompanied by Mr. R. B. Pierpont, agent and manager of their branch at No. 240 Randolph street, Chicago. Mr. Burdick is representing the company in their specialties in both steam railroads and electrical work from the Atlantic to the Pacific. His acquaintance with electrical and railroad interests throughout the country is one enjoyed by few other men.

Mr. J. H. Cooke, who for the past three years has been the secretary and treasurer of the Sunbeam Incandescent Lamp Co. since its organization, has resigned and taken charge of the interests of the Buckeye Electric Co. of Cleveland, Ohio, for Chicago and vicinity, with headquarters at No. 437 the Rookery, Perhaps no man is better known in the incandescent lamp business throughout the West than Mr. Cooke, and the Buckeye Co. are to be congratulated on securing his services to push their well-known incandescent lamps.

The Star Electric Co. has been formed at Des Moines, Ia., with Mr. F. M. Pierce, as manager. It will carry on business as an electric supply and construction house, and will carry a stock of electrical goods. Its headquarters will be in the Marquardt Building on Locust street.

Clark & Marshall have moved from their old quarters to larger ones at 413 the Rookery, Chicago. They are dealers in electric specialties and handle electric fixtures, incandescent lamps, office electric fan motors, etc.

The Chas. Munson Belting Co., through their Mr. Morgan, have furnished the National Electric Manufacturing Co. of Eau Claire, Wis., with one 36-inch double and several others of various sizes for their new factory.

Universal Radial Drill Co.—The above company in getting out their calendar for May show a 30-inch heavy engine lathe. The usual child's face and instructions concerning the lathe accompany the calendar.

Mr. George Cutter has moved his shop to 315 South Canal street, and is just beginning to make things hum in his new and larger quarters. His specialties go as rapidly as ever.

Mr. F. H. Prentiss, president, and Mr. C. H. Rockwell, treasurer of the Buckeye Electric Co., were welcome visitors to Chicago last week.

NEW YORK NOTES.

The Malone, N. Y., Electric Light and Power Co., and the Malone Gas Co. have consolidated with a capital stock of $50,000, the new company being styled the Malone Light, Heat, Power and Coal Co. The company is now building a new electric light station, and will install a Hamilton-Corliss engine costing $6,000. The electric equipment will consist of two 750-light Slattery alternators and complete accessories, all of which were sold to the company by Mr. W. J. Morrison, New York State agent of the Fort Wayne Electric Co. The officers of the new company are as follows: N. W. Porter, president; F. E. Kilburn, vice-president; H. H. Porter, secretary and treasurer; J. H. Findlay, general manager. The company expects to spend $15,000 on the plant, and will shortly put in a Wood 50 arc light machine. When finished the plant will be one of the best designed of its size in this country.

The Standard Paint Co. enjoy a large trade abroad as well as at home for their compounds and paints for electrical purposes, and not long since were in receipt through their advertisement in The Electrical Engineer of an order from Finland.

The Thomson-Houston International Electric Co. has removed its New York offices from 115 Broadway to room No. 11, eighth floor, 44 Broad street—the Edison Building.

☞ Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.

THE
Electrical Engineer.

VOL. XIII. MAY 18, 1892. No. 211.

ARGUMENTS AND MODELS IN THE EDISON "FEEDER" AND "MAIN" CASE.

THE celebrated Edison "Feeder" and "Main" case, of which the electrical public has heard a good deal from time to time, was last week, after more than five and a half years of active preparation, brought up for argument before Judge Green at Trenton, in the United States Court for the Southern District of New Jersey. In its bearing on the incandescent lighting industry, this suit is considered second only to the "Filament" case first argued before Judge Wallace, in New York City, last summer, in which a decision was granted upholding the Edison patent.

In 1886 an electric light plant was installed in the city of Trenton by the firm of Westinghouse, Church, Kerr & Company. The Edison Electric Light Company believed this installation infringed their patent of Mr. Edison of September 19, 1882, No. 264,642. on the use of *feeders* in a system of distribution. This patent states that a feeder system is one comprising two distinct parts, each of which has an independent function. One part, that to which the lamps are connected, is so calculated that the greatest loss or "drop" in pressure will be so slight as to be negligible as far as it affects the relative candle power of the lamps in different portions of the district lighted ; this is the "consumption circuit." The other part is that which connects the consumption circuit with the generating station; it has no lamps on it, and the drop in pressure to be found therein does not affect the relative candle power of the lamps on the consumption circuit; this is the "feeder."

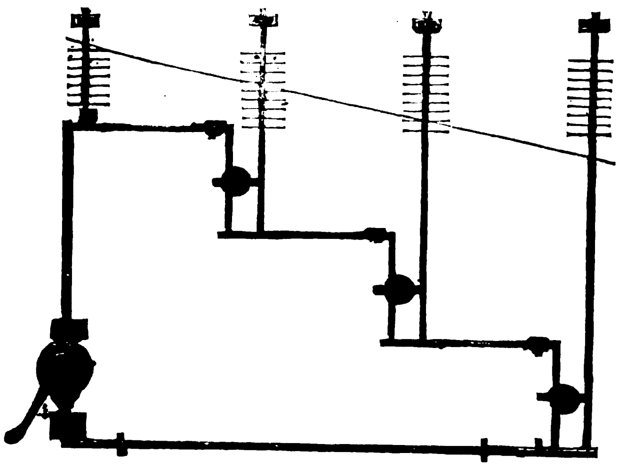


FIG. 1.—WATER ANALOGUE SHOWING SERIES SYSTEM OF DISTRIBUTION.

Suit was brought, and after five and a half years of bitter fighting it has reached the long-desired stage of argument.

A case of this sort is of a very technical nature, and when it is appreciated that within a period of one or two days sufficient instruction must be given to enable a judge to understand fully the meaning conveyed by the terms "volts," "amperes," "drop," "electromotive force," "multiple arc," "series," "potential," "candle power," "B. W. G." "ohm," and the thousand and one other things which are necessary to a comprehension of the subject, it will be seen that the lawyers have an unenviable task before them.

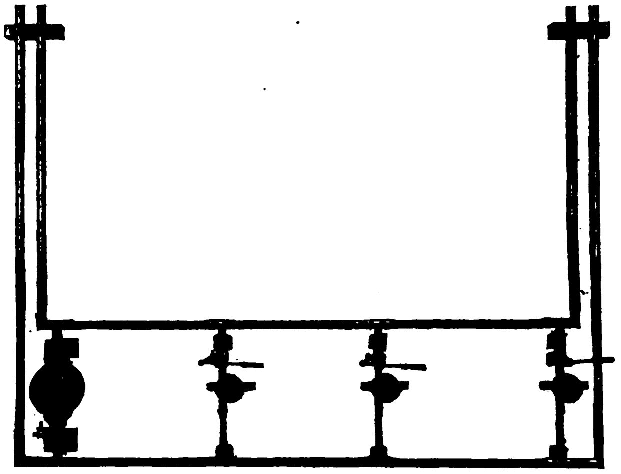


FIG. 2.—WATER ANALOGUE SHOWING MULTIPLE ARC SYSTEM OF DISTRIBUTION.

To save time, to make a few words accomplish as much as many, to illustrate each step of the argument as it is unrolled, has necessitated the preparation of quite a collection of physical apparatus. No care or expense has been spared in preparing such material as will conduct the judicial mind, by easy yet rapid stages, to a point where it will be competent to form an opinion.

To give a clear idea as to what is shown, the various exhibits will be described in detail :

1. *Bird's Eye View of Defendant's Pole Line.*—On a table ten feet long by four in width is a map of that portion of the city of Trenton which was, in 1886, covered by the pole line of the defendant. On this map, which also shows the premises supplied with current from the mains, are erected little brass poles, 3½ inches in height, supplied with cross-arms and insulators as originally used. From a structure representing the cupola of the central station, emanate the four sets of feeding conductors which run to those portions of the town where they join the network of mains. The feeders are what are termed "split feeders," that is, instead of using one large-sized conductor for each polarity, several smaller ones are connected up together, to get the same carrying capacity. The conductors of the model are of red, black and blue silk, a color for each side of the three-wire system. The mains, which in the origina

installation were No. 00 wire, are shown in the exhibit by colored strands of very heavy corded silk. This model is designed to clearly indicate to the Court just what conductors were run and how, and their relative bearing towards one another.

2. *The Water Analogues.*—The patent in suit refers to translating devices connected in multiple arc, as contrasted with those connected in series. Electrical text-books have for years made use of the water-wheel and a series of pipes as an excellent illustration (on paper) of the characteristics of the two methods. It remained for this trial, however, to first show the *actual* working of water-wheels in series and in multiple arc. The illustrations, Figs. 1 and 2, show these two models. As will be seen, Fig. 1 shows a closed system of glass tubing, with three water-wheels and a rotary pump included in its circuit. The tube system is filled with a colored liquid. Pressure tubes rise from the various levels of the system. When the apparatus is at rest the liquid in all the tubes remains at a uniform height. By turning the pump crank the "difference of potential" is at once shown by the variation in the water-levels in the various pressure tubes, as well as by the revolution of the little turbines. If the main line is closed so as to prevent the water from moving, all the turbines stop. This is the series arrangement.

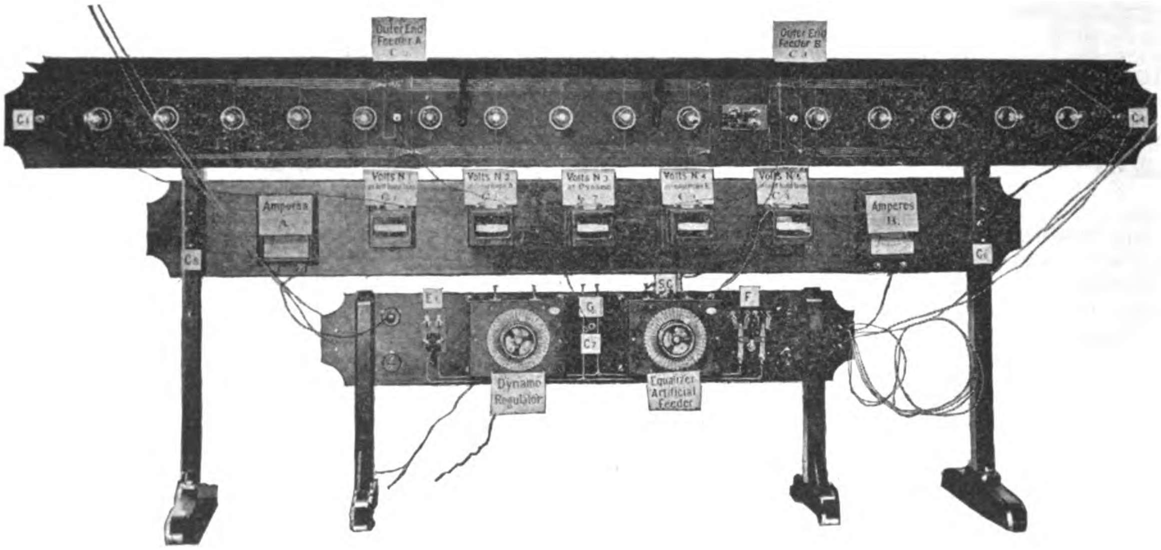


FIG. 3.—MODEL SHOWING COMPLETE FEEDER SYSTEM OF DISTRIBUTION.

An entirely different arrangement is shown in Fig. 2, which illustrates the multiple-arc method of connecting translating devices, such as water-wheels, lamps, motors, or converters. At the left is the pump or source of power, with two pressure tubes to indicate the difference of potential at this point. From the pump extend horizontally two tubes, to which are connected at intervals three turbine wheels, such as are shown in Fig. 1. The horizontal tubes terminate at the right in another pair of pressure tubes. All the valves in the turbine services being closed, the pump crank is turned so as to get a certain difference of potential between the upper (+) and the lower (—) horizontal tubes. The pressure-tubes at the extreme right will also show a difference, but not so great a one as the others, due to the *resistance* of the horizontal mains. Each wheel can be turned on or off independently of the others and, of course, takes its own individual portion of water, which does not flow through the other wheels, as in the case of the series model.

3. *Illustrative Model of a Feeder System.*—To give to the Court a visual demonstration of the electrical characteristics of a feeder system the apparatus shown in Fig. 3 has been devised.

The diagrammatic connections of this apparatus are clearly shown in Fig. 4, which is taken from one of the exhibits entered in the case. As will be seen, the consumption circuit of fifteen lamps is divided into two parts which can be thrown together when desired. Each part is supplied by a different feeder. The current through each feeder is measured on an amperemeter, while the five voltmeters can be connected to as many points of the system so as to obtain simultaneous readings from the dynamo, the ends of the two feeders, and the ends of the consumption circuits. If desirable, the pressure half way down the feeder can also be indicated. This arrangement permits of the demonstration of the various phenomena which are found in feeder systems. An "artificial feeder" or short feeder connecting the consumption circuit directly to the dynamo "bus-bars," can also be employed to show what distortions may result from an unintelligent disposition of conductors. The generator supplying the current for these demonstrations is run in connection with a very neat plant, which was erected for the purpose in a building some 300 feet from the court-room. Of course, the generator must be under the control of the electrician at the court-house, so the plant is arranged as follows: An upright boiler supplies steam to a small marine engine and dynamo (coupled direct) which in turn furnish the power to run a 3 h. p. differentially-wound Sprague motor; the motor is belted to a 15 K. W. dynamo, whose shunt field circuit runs to a hand regulator on the model before the Court. A belt circuit serves as a means of communication between the two portions of the plant.

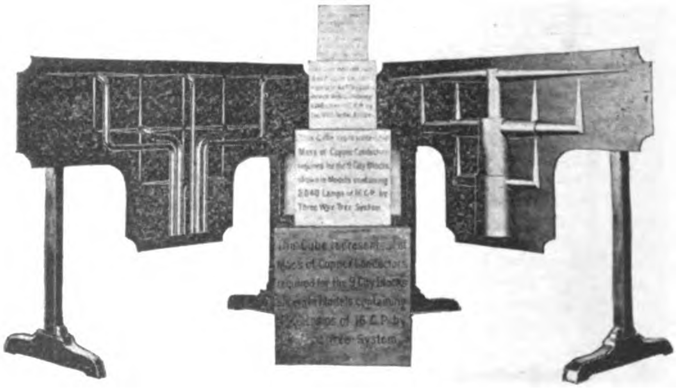
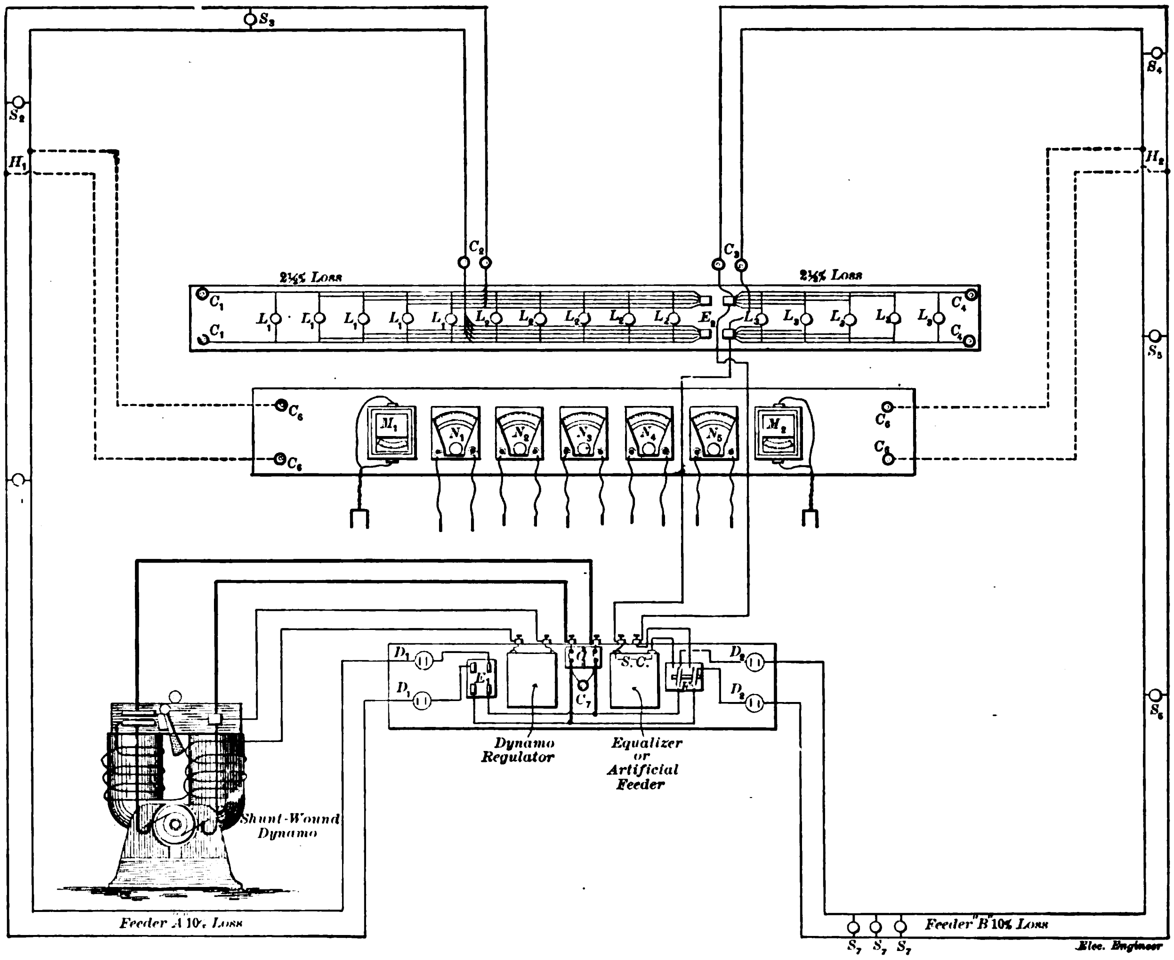


FIG. 5.—MODELS SHOWING ECONOMY OF FEEDER SYSTEM.

4. *Models Showing Economy in Use of Feeder System.*—

As a basis of comparison between the relative economy of the "feeder" system and the "tree" system of distribution, a district of 36 city blocks, in the form of a square, was assumed. The central station was placed at the centre of the square; each block has 16 consumers who used 15 lamps each; conductors were run from the station to supply each of the four quarters of the district with light; in the one case, feeders were employed; in the other case a straight "tree" system was used. Several models have been made to show a comparison between the two systems, and Fig. 5 shows one of a group of these. To the right is shown a model which represents, to scale, the amount of copper in one polarity required to supply one of the quarter districts by the "tree" system; to the left is a model on the same scale, representing the amount of copper required to supply the same district by the "feeder" system; between these models are shown four cubes which represent one one-hundredth of the actual amount of copper required for the quarter-district by the two-wire tree system, three-wire tree system, two-wire feeder system, and three-wire feeder system, in regular order from the floor; the linear dimensions of the cubes, in the same order, are as follows: 29¼ inches, 21 inches, 15⅘ inches and 11½ inches. The total weight of copper for the four quarter-districts by the tree system is 803,250 pounds; the weight when the feeder system is used is 128,789 pounds. This is a reduction from $23.24 per lamp to $3.72 per lamp.



REFERENCES:

C_1, C_2, C_3, C_4, C_5, C_6, C_7.—Points at which to connect the pressure indicators.

D_1, D_2.—Points at which to connect amperemeter.

E_1, E_2.—Double pole switches.

F.—Switch to throw out feeder "B" and throw in the artificial feeder.

G.—Main line cut-out.

H_1, A_2.—Points half way down feeders "A" and "B" at which pressure wires are connected.

L_1, L_2, L_3.—Lamps on the two construction circuits.

M_1, M_2.—Amperemeters.

N_1, N_2, N_3, N_4, N_5.—Pressure indicators.

S_1, S_2, S_3, S_4, S_5, S_6, S_7..—16 c. p. lamps, 100 volts, on feeders "A" and "B" controlled by switches or key sockets.

C.C.—Short circuiting device, cutting out the equalizer.

FIG. 4.—DIAGRAM OF CONNECTIONS FOR FEEDER SYSTEM OF DISTRIBUTION.

Another means of showing graphically the enormous saving obtainable by the use of the feeder system over its predecessor in the art, is exhibited in another set of models. On a board two feet high and eleven feet long is shown the feeder-distribution required for three of the block-faces shown in the models of Fig. 5. Both the feeders and mains are stranded, the conductors being laid side by side; No. 8 wire is employed. Contrasted with this model is one mounted on a board nine feet high and eleven feet long, in which the same lighting is done by the tree system. The relative sizes of the conductors required is shown by taking six No. 8 wires and laying them close together as the conductor for each house. This is done as there is required just six times the copper per house, in the mains by the tree system, as in the feeder system. The contrast can be appreciated by the statement that in the one case 96 No. 8 wires are laid side by side, and in the other case, 576 No. 8 wires are necessary.

In addition to the models enumerated, there is a large rack on which a dozen immense charts on shade rollers are mounted. As will be seen, the judges have opportunities here for getting an insight into electrical subjects which may probably never be vouchsafed to them again.

STORAGE BATTERIES IN CENTRAL STATIONS IN PARIS.

BY

Henry A. Currie

In the editorial in The Electrical Engineer of April 27, on the subject of "Storage Batteries in Central Station Works," mention is made of Paris among other cities, as being one where accumulators are largely in use. As I have given special attention to this particular subject and had occasion last autumn to visit Paris twice with a view to inspecting the several storage battery stations in that city, a few particulars may be of interest. I was greatly surprised to find how comparatively little appeared to be known outside of Paris itself of the very elaborate and extensive scale upon which accumulators are in use there. The type principally in use in Paris is that supplied by the Société Anonyme pour le Travail Electrique des Metaux, from their extensive works at St. Ouen on the Seine. The principle of manufacture adopted by this company is that of casting chloride of lead combined with a small proportion of chloride of zinc with tablets (pastilles). These tablets are then placed in a special mold and ordinary lead cast around them, thus forming a uniformplate. As the process is precisely similar to that adopted by the Electric Storage Battery Co. at Gloucester, N. J., and described in this journal some time ago,[1] it is not necessary to repeat it. The principal feature of the plates as manufactured in France is their size. The plates in all the electric light stations in Paris weigh about 20 kilos (44 lbs.) each. The cells containing from 15 to 25 of these plates are naturally very large. At the time of my last visit (November of last year) the majority of the cells in use contained 25 plates weighing 20 kilos each, making total weight of plates per cell about half a ton. Cells containing plates weighing in all one ton per cell were at that time being prepared. In the city of Paris alone there were then over 75,000 lamps dependent upon these accumulators. The Popp system alone has 16 distributing stations installed with the half-ton cells from which they supply current for over 25,000 lamps. These distributing stations are charged in series of three or more at a time from one central power station. A notable feature of this system is the fact that from four o'clock in the afternoon until the following morning no engines and dynamos are running. That is to say, during the time of heaviest load the lamps are entirely dependent upon the accumulators. At each distributing station there is one attendant taking readings day and night. These readings are all sent in to the head office where they are summarized and tabulated, thus affording an exact record of the output, input and efficiency of each station. To maintain the E. M. F. constant, the ordinary system of auxiliary cells is adopted with however the special feature that instead of using any automatic device the time at which each auxiliary cell is put in and out out of the circuit is registered together with its mean rate of discharge while in use. The total output of each additional cell is thus registered. When charging, each of these cells is permitted to receive the amount in amperes of its discharge, plus a certain surplus to cover loss. This surplus I was given to understand averages about ten per cent. over and above the output.

The manufacturers guarantee the maintenance of the batteries at a fixed cost to the installation companies. This cost is based upon a certain per cent. of first cost and output of the cells. They also guarantee a total efficiency of not less than 63 per cent. under all circumstances. In the event of the efficiency of any station proving less than 63 per cent. certain allowances are made by the manufacturing company to the installation company; and if above 63 per cent. certain allowances are made by the installation company to the manufacturing company. The deductions or allowances are proportional to the amounts above or below the guarantee. Apparently the efficiency has always exceeded the standard of guarantee, showing averages of from 72 to 85 per cent. in the several stations.

In addition to the 25,000 lamps supplied from accumulators under the Popp system there were in Paris numerous isolated plants as well as various electric light companies all using the same type of cell, showing a total in lamp capacity of over 75,000 lamps. I believe at the present time this number has been increased to over 100,000 lamps.

The rapid pace at which the business is extending is of itself a proof of its practical and financial success. Not only are plants already installed being extensively increased but a large number of new installations are being put up in various parts of France, the accumulators being supplied from the works at St. Ouen. A visit to these works was of special interest. The output last autumn averaged about five tons of plates a day. This had been the average apparently during last year. Although plates of various sizes are manufactured, the majority were twenty-kilo plates. It is to the fact of using these large plates and large cells, together with the high efficiency and durability of this special type, that their success is attributed. At certain tests made on behalf of the French Government at the navy trials at Toulon, an efficiency of 90 per cent. was attained with this type. The manufactory at St. Ouen is laid out and systematized with the same precision as the installations. Having been afforded special facilities for investigating every detail of manufacture I was enabled to appreciate what a profitable business is possible both in the manufacture of storage batteries as well as in the supply of current from large installations of the same. In Paris the manufacturing success is of course due to, and dependent upon, a constant market. In this case the market has been made and maintained principally by the companies supplying light. The success of the latter means success of the former. The success of the supply installation companies appears to be largely due to their adoption of the principle of doing everything on a sufficiently extensive scale whereby a proper system of supervision and control is insured. The accumulators thus get proper treatment and care whereby their depreciation is kept within practical limits. Success in this department means considerable increase in the demand for the accumulators; this again enables the manufacturer to keep his works constantly going and thus insure uniformity of work as well as lower prices.

It is stated that all the electric light companies of Paris are supplied with accumulators from the St. Ouen works. It is needless to say this is not done from philanthropic motives. It has been found in Paris as also in many other European cities that the use of accumulators on a large scale by electric light companies is not only practical but economical. What has proved to be the case in Europe may apply equally well in America. Apparently all that is required is a principle similar to that adopted in Paris, namely, a reasonable co-operation between an installation or supply company and a manufacturing company. Some dozen tram cars have lately been started in Paris with the same type of cell.

It is to be hoped these will meet with the same financial success as those in electric lighting.

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[1] The Electrical Engineer, Oct. 8, 1890.

A SCHUCKERT SEARCH LIGHT FOR CHICAGO.

It is stated that the Schuckert Co. of Nuremberg, Bavaria, is to furnish a search light for the World's Fair of about 25,000 c. p. to be seen 60 miles away. Mr. F. Sargent, the electrical engineer of the Fair, will also, it is said, place two large search lights on a tower 300 feet high, with which various special effects will be obtained.

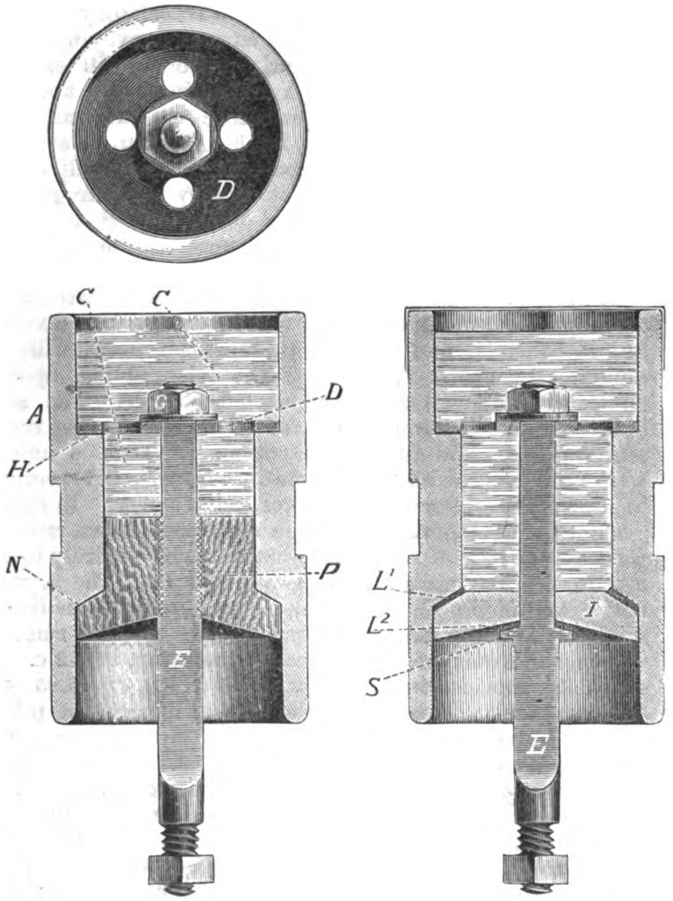
HEWETT'S IMPROVED FORMS OF THE POROUS OIL INSULATOR.

BY

R J Hewett

In The Electrical Engineer of March 30 was given a description of a porous oil insulator invented by the writer and designed specially for insulating trolley wires placed in open conduits. The process of development has produced improved forms of insulators composed of a combination of porous and non-porous insulating materials.

Figs. 1 and 2 of the accompanying engravings show respectively a sectional elevation and plan of one of the improved forms. The shell, or outer portion, is composed of a tube of well-glazed porcelain, glass or hard rubber A. Into the lower part of the smaller diameter of the tube is placed a porous plug P of wood, porous earthenware or other suitable porous material. This plug forms a bottom to the oil chamber C C. The plug P is pressed upward against the beveled shoulder N by means of the shank E, which passes through the plug and then through the perforated plate D, and is tightened up by a nut G. The perforated plate is sustained by the shoulder H. The plan view shows the perforated plate, the object of the perforations being merely to unite the upper and lower oil chambers into virtually one chamber.



Figs. 1, 2 and 3.—Hewett's Improved Porous Oil Insulators.

The oil chamber C C is filled with an insulating oil, such as paraffine, which percolates through the porous plug P and runs off on its conical underside to the inner surface of the porcelain tube, down which it flows in a continuous film to the edge, where it drips off.

A groove round the centre of the insulator is provided for receiving a clasp, by means of which it can be attached to the side of the conduit or manhole. A wire holder is attached to the lower end of the shank E. The porous plug P is composed of fine-grained wood, thoroughly seasoned by a special process which drives out all air and resin and thoroughly shrinks the plug so that no further shrinkage can occur.

In Fig. 3 is shown another form of insulator, in which the porous part is reduced to still smaller dimensions. The bottom of the oil chamber C is composed of a disc of non-porous material I, through the centre of which passes the shank E. A washer of felt L^2 is placed between the shoulder S of the shank and the disk I. Another porous washer L^1 is placed between the beveled shoulder of the tube and the edge of the disc. The oil percolates through these two porous washers and runs down on the surface of the disc and bell as in the other forms. By adjusting the nut G the compression on the porous washers can be varied and the quantity of oil fed through can be regulated. The cap J serves as a covering for the oil so as to exclude dust, etc.

ELECTRIC RAILWAY POLE-LINE CONSTRUCTION.

BY

W. F. D. Crane

PART II.—WOODEN POLES.

Outside of the appreciable saving in first cost, and, perhaps, less need for care and expense in the insulation of the trolley line, since wood is itself a partial non-conductor, wooden poles are not desirable where reliable and permanent construction is sought. In order to obtain the strength necessary to support the overhead construction, wooden poles have to be of considerable bulk, which detracts from the appearance of the street. Moreover, wood deteriorates with comparative rapidity; the pole continually yields under the strain, necessitating the frequent adjustment of span wire or the resetting of the pole; and, unless inspected and painted frequently with a care seldom given, the poles rot rapidly at the ground line where the breaking strain is greatest. It is therefore possible, in view of the rotting which is not always accessible or easy to detect, to have an accident, which at a comparatively early date shall not only inflict a local damage but destroy a considerable portion of the line. It is the existence of these contingencies, together with lack of strength and the difficulty of adequately avoiding early deterioration, that create the demand for the very much stronger and more expensive iron pole, as noted in Part I of this article.

There are, however, frequent uses for wooden poles, dictated by economy or other considerations (as in the case of towns with small traffic), extensions into sparsely settled territory, connections through open country between populous centres; or similar cases where wooden poles most economically answer the purpose and can be used to advantage.

Poles of pine, cedar, chestnut, spruce, cypress, tamarack and other woods are most frequently in demand. Of these spruce, cypress and tamarack, and occasionally poplar, have been used, more especially in or near the localities in which they are procurable. Spruce, when set, makes a handsome line, possessing strength and elasticity, but its short life of two or three years makes its ultimate cost expensive and renders it fit for temporary construction only. Cypress and tamarack both possess excellent lasting qualities. The cost of transportation and the uncertainty of the supply has, however, to a large extent limited their use in northern fields where other woods are more easily obtained.

Cedar, pine and chestnut are abundant, and poles are usually selected from one of these woods. White cedar and chestnut are selected both for their cheapness, quick delivery and railway qualities. Pine, whether of the Michigan or so-called Norway pine, or of the Georgia or North Carolina so-called yellow pine, is the wood usually used for manufactured poles. These manufactured poles are made with a wide variety of shape and finish according to the choice of engineer or maker. Some have the body of the pole turned round, others sawed square or octagonal, with butt full size of the natural wood; others have the same general shape the full length of the pole.

Cost, quantity, time required for delivery and other considerations will naturally affect the choice of pole where little attention is given to the appearance of the line. Undoubtedly, where wood is used, the manufactured pole, with preference for the octagonal, for streets in towns, presents the best appearance.

Following is a list of standard sizes of octagonal pine poles for railway purposes:

6-inch top.	9-inch butt.	28 feet long.
7 "	10 "	28 "
8 "	11 "	28 "
6 "	10 "	30 "
7 "	11 "	30 "
8 "	12 "	30 "

The specifications should read as follows:

Pole to be — ft. long; — in. top; — in. butt; sides to be sawed uniformly octagonal and top neatly pointed; timber to be selected straight, free from knots and shakes, sides to be painted with one coat of paint; butt to be painted for six feet with asphaltum or other preservative compound.

The specifications of a Georgia pine pole to be used on street 60 feet or less wide, drawn up by some engineers, call for a pole 28 feet long, 7-inch top, 10-inch butt, to be sawed square, with edges chamfered and top pointed.

Orders for round or natural wood poles should specify that poles must be live, sound timber; butts cut, well proportioned and reasonably straight; peeled, knots trimmed smooth; and suitable for electric railway (or wire carrying) purposes.

Present practice has almost entirely abandoned the use of the 6-inch top pole for side-pole construction and requires poles with 7-inch tops for streets 30 to 40 feet between curbs; 8-inch tops for streets 40 to 60 feet between curbs; 10-inch tops for pull-off or strain poles, and in the case of round wood poles, demands the largest butts obtainable.

Centre poles on straight tracks may, if circumstances permit, have 6-inch tops, on account of the lighter strain they are called upon to bear. Where centre poles are liable to suffer damage from collision with vehicles, they should be protected by substantial wheel guards or an iron sheathing extending two or more feet above the ground. Centre poles on curves subjected to side strains should be well guyed and be heavier than those used on the straight line. Bracket-arm poles should preferably have at least 7-inch tops except on curves, where they follow the above rule for centre poles.

As mentioned in the early part of this article, wooden poles quickly deteriorate unless subjected to frequent inspection, and unless means be used to protect the wood against weather influences and contact with ground moisture. Before setting, the butts for a foot or more above the ground should be thoroughly saturated with hot tar or painted with one of the penetrating preservative compounds sold for this purpose. Too much care cannot be given to this process; upon its thoroughness will depend in large measure the future life and reliability of the pole. Both before and after setting the poles should be painted, and painted thereafter as often as they require it.

Many of the remarks in Part I relating to iron poles, referring to setting in concrete, allowances for rake, elastic limits, tension of span wire, lengths of poles for side, centre or bracket-arm construction and other considerations, will be found applicable to wooden poles.

THEORETICAL ELEMENTS OF ELECTRO-DYNAMIC MACHINERY—IV.[1]

BY

A. E. Kennelly

POTENTIAL DISTRIBUTIONS (*Continued*).

An important system of flux and potential distribution is that established within an endless solenoid, or what is practically a helix with its two extremities united. Such a solenoid completes its magnetic circuit entirely within itself and has no exterior flux. It therefore has no external magnetic potential. In the practical application of this case, attention has sometimes to be paid to the departure from the strict definition of a solenoid, for a helix is virtually a solenoid plus a conductor along the axis, just as motion along a spiral is circular plus a translatory advance in the axial line; so that a closed current conveying helix, however closely wound, and nearly uniform, will exercise some attractive influence upon a magnetic needle, and thus evidence an external flux, unless before the extremities of the coil are joined, one wire be led back to its starting point parallel to the axis, a proceeding which will cancel out the axial component except at very close range. At all ordinary distances, the closed helix will then be deprived of external magnetic influences, no matter how tortuous the curve its axis may follow.

Within this closed solenoid there will be a distribution of magnetic potential, but it will be complex, as also the flux it controls, and difficult to represent graphically or numerically, unless the axis of the solenoid lies upon a circle. In this case the distribution is simple. The solenoid will then assume the form of an anchor ring represented in plan and diametral sections by Figs. 6 and 7, where N O P is the axis of revolution, Q R S, T U V, sections of the helix surrounding the coil axis G H K. In such a system the equipotential surfaces are planes drawn radially through the axis of revolution, but confined entirely to the interior of the ring, such as AD, WX, and YZ. The M. M. F. active within the ring is 4π times the current turns linked with it. If there were 180 turns of wire on the ring, as shown, and a current of 2 amperes circulating, or 0.2 C. G. S. units, the E. M. F. would be $4\pi \times 180 \times 0.2$, or 45.25 ergs per unit pole.[2] This will be the total difference of potential for one complete circuitation within the ring, representing a rate of change of potential of 0.1257 erg on unit pole per degree of revolution round the axis N O P. This gradient is definite, but the potential at any plane is arbitrary, and may be selected at will as a starting point. Once chosen, the potential is evidently cyclic, and increases or diminishes by $4\pi nc$ ergs in each revolution, according to the direction of circuitation. If there is more than one layer of wire on the ring, and each layer be uniformly wound, the system may be considered as a combination of independent solenoids, one for each layer. The potential in the interior will be that due to the sum of the solenoids, while at any point in the winding space the potential will be that due to the layers outside, those within the point's axial radius having no influence beyond their surface.

Within the anchor ring, the flux, necessarily perpendicular to all the successive equipotential planes must follow circles concentric with the axis of revolution N O P. The intensity will be uniform along any one circle, and will be equal for equal circles, but it would be different in circles of different radii, being weakest at the outer side D E F, and strongest at A B C, varying inversely as the radius of revolution. With reference to what has appeared in Part II, on the field surrounding an infinite straight conductor, it is evident that any steady current c making n uniform turns round an anchor ring of wood or other non-magnetic material, produces throughout its interior exactly the same distribution of potential and flux that a current of nc units flowing along the ring's axis of revolution indefinitely prolonged would produce throughout all space. The circular solenoid produces within the finite limits of its interior the condition that an infinite conductor would establish in infinite space.

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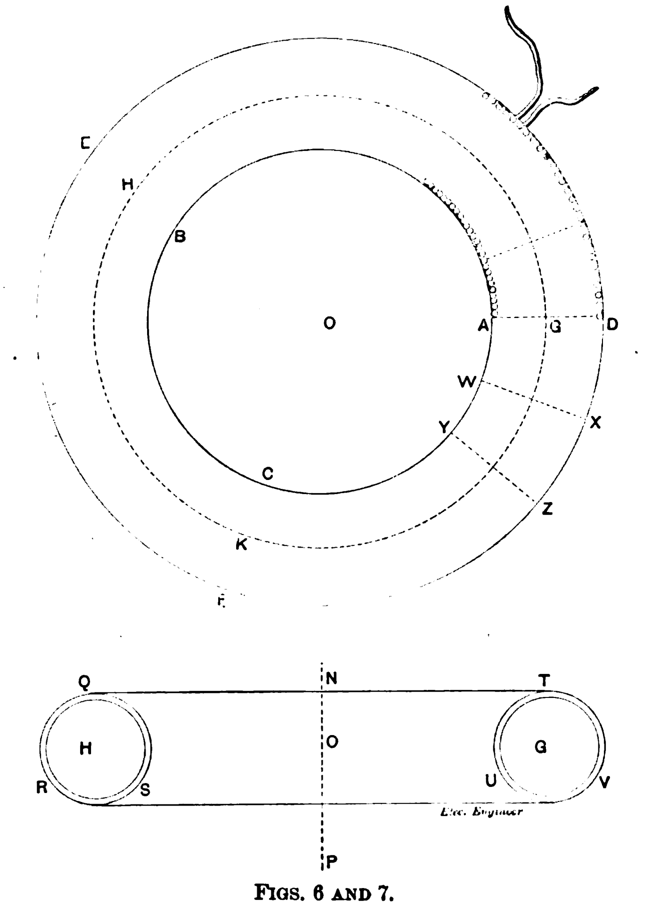
[1] Copyrighted 1892 by A. E. Kennelly.

[2] The dimensions of magnetic potential being $M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$, magnetic pole $M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-1}$ and energy $M L^2 T^{-2}$, it is important to observe that potential is equivalent to energy ÷ pole, and when expressed in ergs, implies ergs expended on or by a unit pole.

This analogy suggest what is, in fact, readily proved, that the radial planed system of potentials and circular distribution flux is not dependent upon the cross-section of the solenoid. We have thus far supposed it to be circular, but it might be square, elliptical, or of any arbitrary shape, provided that its surface was a surface of revolution, having the equivalent straight wire for its axis. The field due to the equivalent current along the infinite axis would still reside within the coil. From the results in Part II, the magnitude of B would be there represented by $\frac{4\pi nc}{2\pi r}$, or $\frac{2nc}{r}$, where r is the radial distance of the point considered from the axis of revolution. In a solenoid whose cross-section is of small dimensions compared with the radius of revolution, B is nearly uniform in intensity, and if the cross-sectional area be denoted by a, the flux within the solenoid will then be $\varphi = Ba = \frac{2nca}{r}$. If, however, the cross-section of the solenoid be of such shape and dimensions that the intensity varies considerably in different parts of it, the area must be multiplied by the average B to give the total flux, or by the flux intensity existing at the centre of gravity of the area, considered as a thin material lamina.



Figs. 6 and 7.

The general case of potential distribution round a current has been only determined in a comparatively small number of instances of which the foregoing are the simplest examples. Yet in order to determine the distribution of flux existing through space in the vicinity of a given system of conductors, it is usually simpler to calculate the distribution of potentials when it exists, and deduce the flux from the gradient, than to compute the general value of B directly. The difficulty in either case is essentially one of summation, for each small element of a current-conveying conductor contributes its own share to the potential or flux at a point independently of all the others, and the geometric sum of all these elementary potentials or intensities is the resultant at that point.

The rule for determining the magnetic potential of any circuit at any point is as simple as it is often difficult to numerically apply. Let a sphere of one centimetre radius be described round that point as a centre, and let a straight line commencing at this point centre move round the circuit considered, in the direction of the current. The trace of its path cut on the unit sphere will form some closed curve and the area of the spherical surface enclosed will be the solid angle subtended at the point by the circuit. This, multiplied by the strength of the current, will be the point's potential. This shows that for circuits comprised in one plane, the potential of that plane is everywhere zero, or some multiple of 4 π, for the solid angle subtended by the circuit will vanish at any point upon it. Also, if two or more loops in a circuit stand behind one another when viewed from a point, so that the radius vector makes reentrant loops on the unit sphere in contouring them, the overlapping areas must be added to the total surface within the boundary, or, in other words, the potentials of superposed loops are superposed.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS.—XI.

(*Concluded.*)

BY

Francis B. Crocker and S. S. Wheeler.

Chapter VII (*Concluded*).

7. *Voltage.*—There is no convenient way of testing voltage except by means of a voltmeter. Unfortunately a really satisfactory voltmeter is rather an expensive instrument. A good voltmeter should be very accurately calibrated because an error of one per cent. in the voltage of an incandescent circuit is objectionable, whereas the same error would be insignificant in almost any other practical measurement. A voltmeter should have as high a resistance as possible—at least several hundreds or thousands of ohms—in order not to take too much current which might lower its reading on a high resistance circuit. It should not be affected by the magnetism of a dynamo or motor at any distance over four or five feet. The voltage of any machine or circuit is tested by merely connecting the two binding posts or terminals of the voltmeter to the two terminals or conductors of the machine or circuit. In the case of a dynamo or motor the voltmeter is usually applied to the two main binding posts or brushes of the machine to get the external voltage of the machine. This external voltage is what a dynamo supplies to the circuit and it is what a motor receives from the circuit. This is called the pole difference of potential or terminal voltage and is the actual figure upon which calculations of the efficiency, capacity, etc., of any machine are based.

A dynamo for constant potential circuits should, of course, give as nearly as possible a constant voltage. A plain shunt machine usually falls from 3 to 10 per cent. in voltage when its current is varied from nothing to full load. This is due to the loss of voltage in the resistance of the armature, which in turn weakens the field current and magnetism; armature reaction and reduction in speed usually occur also and still further lower the external voltage, but of course this variation is very undesirable. A compound-wound dynamo should not fall appreciably from no load to full load; in fact, if it is "over-compounded," it should rise two or three per cent. in voltage to make up for loss on the wiring. The voltage of a constant current dynamo or motor is not important. The current should be carefully measured by an amperemeter, but little or no attention is paid to the voltage in practical working; in fact, it changes constantly with variations in the load. It is of course necessary, however, to measure it for a test of efficiency or other exact tests.

A very simple and fairly accurate method of measuring voltage is by means of ordinary incandescent lamps. A little practice enables one to tell whether a lamp has its proper voltage and brightness. In this way it is easy to tell if the voltage is even one or two per cent. above or below the normal point. Voltages less than the ordinary can be tested by using low voltage lamps or by estimating the brightness of high voltage lamps. For example, a lamp begins to show a very dull red at one-third and a bright red at one-half its full voltage. Voltages higher than that of one lamp can be tested in this way by using lamps in series. In fact, even 1,000 or more volts can by measured by using 10 or more lamps in series.

8. Current.—This is, of course, measured by means of an amperemeter, and this instrument is usually cheaper than a voltmeter because it only contains a comparatively small amount of wire, and does not ordinarily require to be accurate within one or two per cent. In testing the current of a dynamo or motor all that is necessary is to connect an amperemeter of the proper range in series with the machine to be tested so that the whole current to be measured passes through the instrument. To test the current in the armature or field alone, the amperemeter is connected in series with the particular part. In the case of a shunt-wound dynamo it is well to entirely open the external circuit in testing the current used in the field coils in order to avoid mistake, for the same reason the brushes of a shunt motor should be raised while testing the current taken by the field. In a constant current (series wound) dynamo or motor the same current flows through all parts of the machine and the rest of the circuit, consequently the measurement of current is very simple.

In testing the current produced by a dynamo it is often quite a problem to consume it. A bank of lamps, for example, to use the whole current generated by a dynamo of 110 volts and 200 amperes would be very expensive. A sufficient number of resistance boxes for the purpose would also be very costly. The simplest and cheapest means to consume a large current is to place two plates of metal or carbon in a common tub or trough filled with a very dilute solution of sulphate of soda or sulphuric acid. The main conductors are connected to the two plates, respectively, and the current passed through the solution. The resistance and current are regulated by varying the distance between the plates and the depth they are immersed in the liquid. The energy may be sufficient to boil the liquid but this does no harm.

9. Speed. This is usually tested by the well-known speed meter or speed counter which consists merely of a little spindle which turns a wheel one tooth each time it revolves. The point of the spindle is held against the centre of the shaft of the dynamo or motor for a certain time, say, one minute or one half minute, and the number of revolutions is read off from the position of the wheel.

Another instrument for measuring number of revolutions per minute is the tachometer. The stationary form of this instrument is shown in Fig. 27. This requires to be belted by a string, tape or light leather belt to the machine the speed of which is to be tested. If the sizes of the pulleys are not the same, their speeds are inversely proportional to their diameters. The portable form of this instrument is applied directly to the end of the shaft of the machine like the speed meter. These instruments possess the great advantage over the speed meter that they instantly point on the dial to the proper speed and they do not require to be timed for a certain period.

A simple way to test revolutions per minute is to make one large black or white mark on the belt of a machine and note how many times the mark passes per minute; the length of the belt divided by the circumference of the pulley gives the number of revolutions of the pulley for each time the mark passes. If the machine has no belt, it can be supplied with one temporarily for the purpose of the test, a piece of tape with a knot or an ink mark being sufficient. Care should be taken in all these tests of speed with belts, not to allow any slip; for example, in the case of the tape belt just referred to, it should pass around the pulley of the machine and some light wheel of wood or metal which turns so easily as not to cause any slip of the belt on the pulley of the machine.

10. Torque or Pull is tested in the case of a motor by the use of a Prony brake. This consists of a lever L L of wood clamped on to the pulley or shaft of the machine to be tested, as indicated in Fig. 28. The pressure of the screws S S is then adjusted by the wing nuts until the friction of the clamp on the pulley is sufficient to cause the motor to take a given current and run at a given speed. Usually the maximum torque or pull is the most important to test and this is obtained in the case of a constant potential motor by tightening the screws S S until the motor draws its full current as indicated by an amperemeter. What the full current should be, is usually marked on the name plate; if not, it may be assumed to be about 8 amperes per h. p. for 110-volt motors, 4 amperes per h. p. for 220-volt and 1¾ ampere per h. p. for 500-volt motors. The torque or pull is then measured by known weights, or more conveniently by a spring balance P. If desired, the test may also be made at three-quarters, one-half or any other fraction of the full current.

The torque or pull of a constant current motor is found by adjusting the screws S S until the armature runs at its normal speed.

The torque or pull of a dynamo, that is, the force required to drive it, is tested by a transmission dynamometer. There are several forms of this apparatus but none of them are very satisfactory. In the cradle dynamometer the dynamo is placed on a platform which is hung on a pivot or fulcrum. The axis of the shaft of the dynamo is adjusted so that it exactly coincides with the axis of the pivot or fulcrum. When the dynamo is run by a vertical belt, the pull or torque tends to cause the dynamo to turn about its axis of suspension, and the force of this torque is measured by the amount of weights required to keep the dynamo and platform horizontal. In a modified form of the cradle dynamometer the dynamo is placed in a water-tight box which floats in another box filled with water, instead of being hung on a pivot. It is usually much easier to test the torque of a dynamo by running it as a motor and testing it by the Prony brake method described above. The torque of a dynamo is practically equal to that of a motor under identical conditions.

11. Power.—The electrical power of a dynamo or motor is found by testing the voltage and current at the terminals of the machine, as described in sections 7 and 8 of this chapter, and multiplying the two together, which gives the electrical power of the machine in watts. These watts divided by 746 are then converted into horse power, thus:

$$\text{Horse power} = \frac{\text{volts} \times \text{amperes}}{746}.$$

The mechanical power of a dynamo or motor, that is, the power required for or developed by it is found by multiplying its torque or pull, determined as described in the previous paragraph, by its speed, determined as described in section 9 of the present chapter, and by the circumference of the circle on which the torque is measured, and dividing by 33,000, that is—

Horse power $= \dfrac{P \times S \times 6.28 \times R}{33,000}$ in which P is the torque in pounds, S the speed in revolutions per minute and R the radius at which P is measured.

12. Efficiency.—This is determined in the case of a dynamo by comparing the mechanical power required to drive it by the electrical power generated by it, that is—

$$\text{Efficiency of dynamo} = \frac{\text{Electrical power}}{\text{Mechanical power}}.$$

The efficiency of a motor is the mechanical power developed by it divided by the electrical power supplied to it, that is—

$$\text{Efficiency of motor} = \frac{\text{Mechanical power}}{\text{Electrical power}}.$$

These are the *actual* or *commercial* efficiencies of these machines and should be about 90 per cent. in machines of 10 h. p. and over.

The so-called "electrical efficiency" is misleading and of little practical importance and should not be considered in commercial work. The mechanical and electrical power in the above equations are determined as described in the last section.

13. Heating.—This is measured by applying a thermometer to the various parts of the machine, after it has run at full load for one or two hours, in fact a large machine does not reach its maximum temperature until it has run for three or four hours.

The bulb of the thermometer is applied directly to the surface of the field coil or other part. To test the armature it must, of course, be stopped. The thermometer bulb should be covered over with a bunch of waste or cloth to keep in the heat. The temperature of the armature, field coils, bearings, etc., should not rise more than 40° C. or 72° F. above that of the surrounding air. A very simple test of heating is to apply the hand to the armature, etc., and if it can be kept on without great discomfort, the temperature is perfectly safe. See "Heating" in chapters on Locating Faults.

14. Sparking at the commutator cannot be actually measured, but it is a very important matter and in any test it should be carefully observed whether the sparking is excessive or not, and if so, what it is due to. (See "Sparking" in chapters on Locating Faults.)

15. Magnetism.—Magnetic measurements are difficult to make with the ordinary apparatus used in practical work. The proper method of testing magnetism is with the ballistic galvanometer. To test the magnetic leakage in a dynamo or motor, for example, a coil of wire connected to the galvanometer is put around the field magnet and the current in the field is stopped the deflection of the galvanometer needle being noted. A coil of the same number of turns is then put around the armature and the swing of the galvanometer is again noted. The first deflection is to the second as the number of lines of magnetic force in the field is to those in the armature, provided the angles of deflection are only a few degrees.

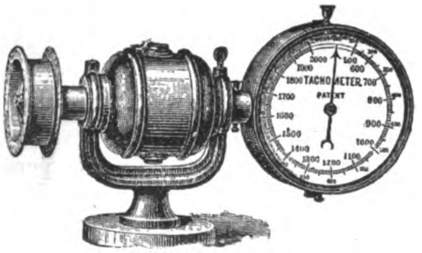


FIG. 27.

An ordinary detector galvanometer can be used for this work if it is not damped by wings to prevent its swinging freely. A low-voltage Weston voltmeter or the calibration coil of a high-reading one, can also be used very conveniently for magnetic measurements in place of the galvanometer as described by A. S. Ives in the *Electrical World*, Jan. 2, 1892.

16. Line or Circuit testing for resistance, insulation, current, voltage, etc., is performed by exactly the same methods as those just described for making the corresponding tests on dynamos and motors. For example, in testing the insulation resistance of a line or circuit, one wire is connected to the line and the other to the ground (a gas or water pipe is convenient for this purpose) instead of connecting one wire to the commutator and the other to the frame of the machine as described for testing the insulation resistance of a dynamo, otherwise the test is exactly the same.

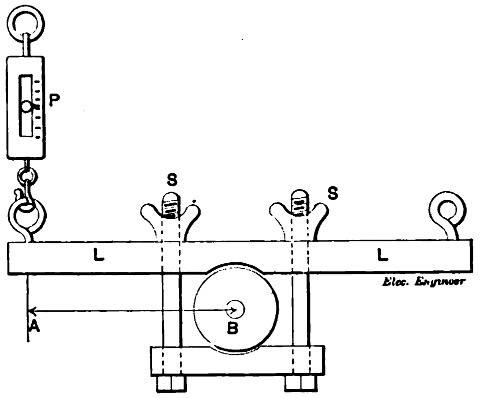


FIG. 28.

THE EXHIBITION OF THE SOCIETE FRANCAISE DE PHYSIQUE.

THE annual exhibition of the Société Francaise de Physique was held on the 19th, 20th and 21st ult, in the building of the Société d'Encouragement. Among the more noteworthy events forming part of the proceedings was a repetition by M. d'Arsonval of the Tesla and Elihu Thomson experiments. The experiments were very successful, and many were of a novel character. M. d'Arsonval made a great point of showing the difference in the physiological effects of alternating currents of different kinds. M. P. Janet showed an apparatus for the stroboscopic study of alternating currents. MM. Richard Frères showed an electric kinemograph, and a hydraulic dynamometer, which had been used in determining the variation of tractive effort with the speed of a vessel. The same firm also showed a Deprez-d'Arsonval galvanometer which registered photographically. M. Ducretet showed some apparatus constructed for carrying out experiments with polyphase currents, and M. Besson exhibited a small plant arranged to enable accumulators to be charged by means of the Giraud thermo-electric stove.

AN ELECTROMAGNETIC LIGHT COIN DETECTOR.

MESSRS. NAPIER & SON show at the Crystal Palace Exhibition an electromagnetic light coin rejector for the use of bankers or mints. The coins are pushed in succession from the balance pan onto a knife-edge, and according as this knife-edge is at the right-hand limit of its range, or the left-hand limit, the coin, when pushed on it, tilts off to the "light" channel or the "full-weight" channel as the case may be. The right or left position of this shifting knife-edge is determined by an electric contact made by the balance beam; this brings an electromagnet into action. The coins are run through the machine at the rate of about sixty per minute by the action of turning a handle.

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VOL. XIII. NEW YORK, MAY 18, 1892. No. 211.

It is the due combination of theoretical knowledge with practical skill which forms the most efficient and reliable character.--Joseph Henry.

WHAT ELECTRICITY IS.

THE discussions as to the nature of electricity which stir the electrical fraternity from time to time, and which, like the sun spots, break out from no assignable cause, if they have not led to a definite solution of the question nevertheless serve as periodical reminders of the fact that the world is still in ignorance; and hence to that extent at least they serve a useful purpose. One of the peculiar phases which these discussions have of late assumed is a development of what, for want of a better term, we may call the "corpuscular theory" of electricity, the adherents of which seek to prove that electricity is "ether in motion," that is, that an electric current is due to an actual transfer of ether particles, or, to use a mechanical analogy, that a dynamo is an ether pump. Thus far the adherents of this theory have based their arguments on purely theoretical deductions but a recent attempt to prove the theory experimentally deserves some notice. This has been undertaken by Dr W. W. Jacques who, in an address delivered before the American Academy of Arts and Sciences, in Boston, gives the results of his experiments. Before citing the results actually reached by him, Dr. Jacques sought to prepare the minds of his hearers by a series of analogies in which he characterized a current of electricity as a "breeze of light." He also likened the action of the ether breeze to a breeze of air, the weathervane of the former being the magnetic needle, and its anemometer the galvanometer. We pass over the slight fault in this analogy due to the fact that the magnetic needle points at right angles to the direction of the supposed ether breeze, in order to give another analogy which the lecturer appears to have looked upon as of special importance in proof of his theory. If we send a steady current of electricity through a wire, we get no inductive effect in a neighboring conductor; but interrupt the current, so that it pulsates, say 100 times per second, and we get current effects of the same frequency in the second conductor. Now, take a pipe carrying a steady current of air; it emits no sound. But break up the current of air into 100 pulsations per second, such as might be done by an organ pipe, and the ear perceives a sound, due to the radiated air waves. According to Dr. Jacques, "analogy indicates that, in the former case, we have a current of ether (or electricity), by rapid interruptions, converted into waves in the ether (or electrical waves)." We agree with Dr. Jacques that we must have stronger proofs than the indications of analogy, and hence we come at once to the crucial experiment devised by him to show the identity of the electric current and a current of ether. This is based upon a conception of Clerk-Maxwell to illustrate the relationship between the electrostatic and electromagnetic units. For this purpose Dr. Jacques employs a pair of discs attached respectively to the arms of a delicate balance, and placed so that each swings freely between a pair of discs, one placed above and the other below the disc attached to each balance arm. There are six discs in all. Theory indicates that if the discs be similarly charged electrically there will be no mechanical action between them, if they be moved with the velocity of light, 300,000,000 metres per second. Dr. Jacques has undertaken to measure the action which does take place at the velocity at which the earth moves in its orbit around the sun, combined with that of its approach towards the centre of star drift in the constellation Hercules. In order to get definite results, Dr. Jacques works on the differences in these combined velocities resulting from the varying positions of the earth in its orbit. On March 22 the star-drift velocity would have to be added to that of the orbital velocity, and on September 21, subtracted. On December 22 it would have no effect. According to Dr. Jacques, on March 22 the velocity of a point in space, at the Hub, say, should be $\frac{1}{2000}$ the velocity of light; on December 22, $\frac{1}{2500}$; and on September 21, $\frac{1}{2700}$. The balance is employed to measure these differences. Dr. Jacques began his experiments last September, and the results observed are of the order of the magnitude predicted, though he states that accidental phenomena frequently masked that for which he was searching. It is scarcely necessary to comment critically on a series of confessedly incomplete experiments, but we fail to see how, even if Dr. Jacques' experiments end as he expects, they will prove in the least that the electric current is a *bodily forward movement of the ether*. He will merely have shown again the correctness of the theory that a moving electrified body is equivalent to an electric current, but in a manner far more cumbersome and subject to error than the beautiful experiment performed by Rowland in 1876, and by others in various ways. While electromagnetic phenomena, above all others, are interconvertible, we are scarcely justified in assuming that the effect of, or force created by, a relative motion between two bodies, *is* the motion of one of these bodies itself.

STORAGE BATTERIES IN CENTRAL STATIONS.

Our recent remarks on the above subject have served to bring out a communication which we print on another page and which is well calculated to demonstrate that for central station work the storage battery has already proved itself a powerful factor of economy. Perhaps the most characteristic feature of the cells in the Paris installations is the size of the individual plates, which in this respect are a decided departure from, and, we believe, an improvement over, the size we are accustomed to associate with cells of this nature. This is a step in the right direction and the advantages gained by their adoption are too obvious to require further comment. But aside from the manner of operation of the stations detailed by Mr. Currie, there is another important feature embodied in the arrangement as it exists in Paris and which we think might be adopted in our country to good advantage. The efficiency of the cells being guaranteed by the manufacturing company and their remuneration being dependent upon the percentage of efficiency, allows the installing and distributing company in the first place to estimate exactly the relative advantages to be derived from the storage cells, while, on the other hand, it secures to them that freedom from the disputes which have only too often resulted in the total abandonment of storage battery work. With a feasible way, as shown abroad, of operating with storage cells it ought not to be difficult to inaugurate the system generally among American central stations; and we do not hesitate to say that a company prepared to furnish and maintain storage batteries and to guarantee their performance at a fixed annual charge will find a large business awaiting them.

FEEDER-AND-MAIN PATENTS.

We have surrendered a considerable amount of space in our current issue in order to present as adequately as possible the points in contest in the hearing on Edison's patent for feeder-and-main distribution, which has just terminated in the United States Court at Trenton, N. J. There is scarcely a central station plant in existence, in this country or abroad, which does not use the arrangement of circuits claimed to be covered by this patent, and hence the dicussion can hardly fail to interest a large constituency of electrical engineers. The real question at issue has been practically narrowed down to the inquiry whether the arrangement of circuits in controversy constitutes a patentable invention, or whether it amounts to nothing more than a well-conceived engineering expedient. The determination of this question in the present case, is by no means easy. A good deal can be said, and, in fact, a good deal has been said, on both sides of the question. In fact, it is by no means easy to sufficiently instruct a judge, however able and intelligent, in the technicalities of electrical science, merely by a few days of argument, so as to enable him to understand thoroughly the point at issue. The Edison Company have however, set up in the court-room a most effective object-lesson, a description of which will be found elsewhere, consisting in part of a full-sized and complete set of central station apparatus for distribution and regulation, which will enable the whole operation to be understood almost at a glance. The arguments of counsel pro and con have occupied the attention of the court for more than a week, but we have succeeded in presenting the essence of them in our report in another column.

SWITCHING RAILROAD TRAINS BY ELECTRICITY.

Inspector Brettman, of the Prussian State Railways, writes to the *Deutsche Bauzeitung* to suggest the use of electric power for switching cars, and calls attention to the high cost of switching by locomotives. The annual statement for the fiscal year 1889-90 showed that the switching on the Prussian roads required over ten million locomotive-hours, the fuel alone costing $1,500,000. On adding to this the wages of the engineers and firemen, it appears that 19 per cent. of the cost of the train service is spent on the switching.

Inspector Brettman thinks a cheaper and more serviceable motive power can only be found in electricity, which will soon make its way into railway stations for lighting purposes. He thinks of so arranging electric windlasses between the tracks, that several may be used simultaneously for moving a heavy train, while one would suffice for a few cars. In certain cases he would advise the use of motor cars with gears engaging a rack alongside of the track, these cars being moved from track to track on a sliding platform or turntable. This latter plan, with the substitution of a magnetic traction increaser for the rack and pinion would probably adapt itself to American practice and would seem worthy of attention here as well as abroad. It is evident that the range of travel of a switch-engine is very small as compared with even a horse car, and therefore it is not so much the cost of the long transmission lines, as the feasibility of operating motors on zig-zag tracks, which will govern the use of electrical energy for this purpose.

THE MEETING OF THE INSTITUTE IN CHICAGO.

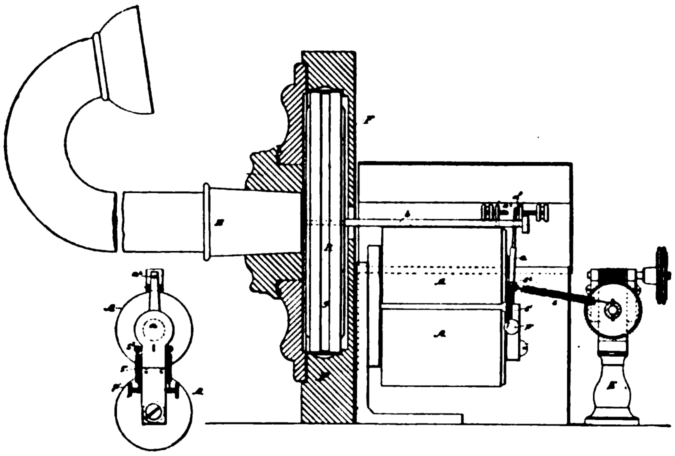
We published last week the preliminary programme of the meeting to be held by the Institute in Chicago next June. It is perhaps the best selection of topics that the Institute has ever had, while the authors are such as to insure a thorough treatment of the questions discussed. It is worthy of note that on the occasion of this visit of the Institute to Chicago—the first Western trip in its history—the West is conspicuously represented on its programme. We observe that it will have contributions not only from well-known engineers in Chicago, but from the universities of Minnesota, Nebraska, Wisconsin and Ohio. This is altogether as it should be, and it is most satisfactory to find the national technical body thus in touch and sympathy with the advanced thought and practice of the great progressive West. It is an interesting fact that while the membership and officers of the Institute have always been very largely drawn from outside New York—as becomes a national body—the proportion of members in the West has not until within the last year or two been fully representative of electrical activity there. New York and vicinity has perhaps never had more than a bare 25 per cent of the membership, while the remainder is scattered all over the Union and all over the world. Of the presidents, only two out of seven have been residents in New York State.

THE SECRET TELEGRAPH RECEIVER.

BY

A. A. Knudson.

It is a well-known fact, that owing to the present general system of telegraph receiving apparatus, such as the loud clicking sounder, a large amount of "leakage" of telegraphic communication is daily going on. A short time ago a number of old telegraphers were discussing this point, and the number and frequency of such incidents which were related was surprising. The usual method employed is very simple and very rarely detected. An operator may be carelessly lounging in the vicinity of a way station, such as a railway office, with his hands in his coat pockets, one hand being busy with a short pencil taking down on a pad important information which the accommodating sounder ticks off and that later may be used to the disadvantage of the sender; or he may be innocently looking over the tape at the stock quotations in a broker's office, while the click of the sounder in a back room informs him what the firm is doing in its operations at the exchange, or other information equally important by no means intended for his ear.



Figs. 1 and 2.—Knudson's Secret Telegraph Receiver.

With a view to trying what could be done by such eavesdropping the writer a short time ago employed an expert operator to call at some of the brokers' offices about Wall street and also some of the hotels in the city to see what he could get in the way of information. Out of some dozen offices he visited he was able to obtain information more or less important from every one of them, and as for the hotels, nothing was easier than to take every message he chose.

In view of the above and of much more evidence that could be furnished it seems there is a demand for an instrument that will not "leak." I have therefore completed a device which so far as it has been tried seems to fill the bill and is constructed as follows:

Referring to the engraving Fig. 1, the magnets A A are used to actuate the armature *a* which is more clearly shown in Fig. 2. Two pointed studs project from its lower part and stand on the concave bottom of holes drilled in the pole extension of the magnet. The armature is held in place by the spiral springs s^1 secured to the adjusting screws p^1. The effect of this arrangement is to reduce the amount of armature friction to a minimum and also bring the magnetic poles of the instrument close together, thereby obtaining the fullest amount of power from the magnet. A special adjusting screw for the retractile spring being clearly shown in Fig. 1 need not be described. The limiting screws a^2 a^3 are secured to the arms *b*, these arms being fastened to a resonator R, of peculiar construction, which is placed in the wooden case F.

This resonator is constructed as follows: Two thin sheets of aluminum are spun in a round shape with corrugated surfaces and with edges turned over, these are slipped over the sides of a band of brass about ½ an inch wide as at *g*, Fig. 1. The whole is about six inches in diameter.

It will be observed that as the limiting screws against which the armature lever plays are in direct metallic connection with the resonator, any movement of the armature, however small, is easily heard at the receiving tube H of the instrument. As a matter of fact, the instruments, as generally constructed, are kept adjusted so closely that no movement of the armatures can be detected with the naked eye, nor can the sounds be heard without holding the ear close down to them; at the receiving tube, however, which takes up the faintest sound from the resonator, the telegraphic signals can be easily read.

It will be noticed that the important results obtained in the magnifying of sound as shown in this instrument are largely due to the excellence of the resonator; in its construction advantage is taken of the well-known sonorous quality of aluminum, which exceeds in this respect all other metals. Other features of importance are the ability to operate lines equipped with instruments of this kind with a very small amount of main battery, and also doing away with the sounder and local battery.

A test of this instrument was recently made between New York and Hartford, a distance of about 140 miles, on a line of the Postal Telegraph-Cable Co. The result showed that a very much less amount of battery was required to operate the line, and the signals were easily read on an extremely small movement of the armature, due, as before stated, to the magnifying qualities of the resonator.

THE COMMELIN-FINOT CADMIUM ACCUMULATOR.

The positive plate of this accumulator, says *L'Industrie Electrique*, is an ordinary Julien positive; the negative plate being preferably an alloy of lead, cadmium and antimony. The liquid is a solution of sulphate of cadmium, to which 10 per cent. of sulphuric acid is added. MM. Commelin and Finot also propose to employ a positive plate formed of twisted lead strip, holding plugs of lead chloride. On charging, the oxygen oxidizes the positive plate as usual, and metallic cadmium is deposited on the negative plate. On discharging, the cadmium combines with the sulphuric acid, cadmium sulphate being re-formed, and the hydrogen liberated from the sulphuric acid goes to the positive plate and reduces the peroxide. The inventors anticipate by this arrangement the complete avoidance of sulphating. The electromotive force of the cell is stated to be 2.5 volts on open circuit, and from 2.2 to 2.15 volts during discharge. The output per pound of plate is 24.5 watt hours.

ELECTRICITY IN THE MANUFACTURE OF WHITE LEAD.

Ammonium acetate is used for dissolving the litharge in the production of basic carbonate of lead—the so-called "white lead" of commerce. The solution is ordinarily used over and over again, and in course of time becomes impure through taking up considerable quantities of copper—an impurity in the litharge. One of the latest improvements employs carbonic acid gas for removing every trace of metal from the acetate, but another improvement, which is said to be even more effective, is to pass through the solution an electric current, electrodes of carbon being employed. In another application of electricity to white lead making, the metallic lead itself is decomposed in an acid electrolyte into an oxygen bearing salt of the metals; the saturated solution being then neutralized, and the salts contained in it being converted into hydrated lead carbonate. The latter is precipitated by the introduction of carbonic acid gas.

Legal Notes.

FINAL HEARING ON EDISON'S "FEEDER AND MAIN" PATENT FOR ELECTRICAL DISTRIBUTION.—I.

THE suit of the Edison Electric Light Company against Westinghouse, Church, Kerr & Co. for an alleged infringement of Edison's patent of September 19, 1882, No. 264,642, covering the use of feeders in a system of electrical distribution, came up for argument on final hearing before Judge Green in the United States Court, at Trenton, New Jersey, on May 9th. Messrs. S. B. Eaton and F. H. Betts appeared as counsel for the Edison Company, and Messrs. E. Wetmore and L. E. Curtis, for the Westinghouse Electric and Manufacturing Company, the real defendant in the case. The suit was originally brought on December 22, 1886, and alleged an infringement of the patent by reason of the construction and operation of a lighting plant in Trenton, N. J., constructed by Westinghouse, Church, Kerr & Co., during the summer of 1886. Most of the evidence taken in the case has consisted of expert testimony of a somewhat technical character. Among the experts of note who have been employed by the complainant are Prof. C. F. Chandler, and Messrs. H. R. Brevoort and W. J. Jenks. The complainants also took by commission at Glasgow the evidence of Sir William Thomson. The experts for the defence were Prof. Henry Morton, Franklin L. Pope, Benjamin S. Church and others.

The arguments of counsel on both sides have occupied some seven days. The importance of the issue involved is scarcely less than that of the lamp case recently heard in the Circuit Court of Appeals in New York. No small part of the time was necessarily occupied in efforts to instruct the presiding judge as to the force and effect of the technical term employed in the patent, and the scientific matters which are presumably so familiar to readers of this journal that it is scarcely necessary to occupy space in attempting to give a synopsis of the arguments. We have therefore attempted to summarize the leading points upon which the counsel for the complainant and defendant seemed to have principally relied in the presentation of the case in order that its merits may be understood. Certain preliminary questions were brought up by a motion to dismiss the bill which had reference to the capacity of the parties and the jurisdiction of the court, but as these have really nothing to do with the merits of the case, we shall make no further reference to them.

The general purpose of the invention as stated in the specification is as follows:

> "This invention relates to a method of equalizing the tension or pressure of a current through an entire system of electric lighting or other translation of electric force, preventing what is ordinarily known as a drop in those portions of the system the more remote from the central station."

The specification then describes the arrangement and construction of the conductors by means of which the patentee proposes to obviate this difficulty and which constitutes the invention sought to be patented. This will be understood sufficiently from the following passage in the specification:

> "To obviate the difficulty, I provide feeding conductors which extend from the generator or generators to the main conductors of the lamp or consumption circuit or circuits, such feeding conductors not having any translating devices connected therewith, and being connected with the main conductors of the consumption circuit or circuits at the centre, ends or other points on such main conductors."

The specification states in substance that the circuit consists of two essential parts, first the feeding conductors, and second the main conductor of the consumption circuit. This will be recognized as the usual arrangement of feeders and mains in all systems of electrical distribution, in which the conductors radiate from a central station and serve a district of any considerable size. The claims of the patent which are alleged to be infringed by the defendants are as follows:

> 1. A consumption circuit, in the main conductors of which the drop in tension is not sufficient to vary practically the candle power of the lamps connected therewith, in combination with feeding conductors connecting the consumption circuit with the source of electrical energy, and having no translating devices connected therewith, the drop in tension upon such feeding conductors not affecting the relative candle-power of the lamps of the consumption circuit, substantially as set forth.
>
> 2. A consumption circuit in the main conductors of which there is a definite small drop in tension not sufficient to vary practically the candle power of the lamps connected therewith in combination with feeding conductors and having no translating devices connected therewith, the loss upon such feeding conductors being greater than upon the main conductors of the consumption circuit, substantially as set forth.
>
> 3. The combination of a consumption circuit, in the main conductors of which the drop in tension is not sufficient to vary practically the candle power of the lamps connected therewith, with a feeding circuit having no translating devices, and extending from the source of electrical energy to the centre of the consumption circuit, substantially as set forth.

THE COMPLAINANT'S CASE.

Ten or twelve years ago, says the complainant, *i. e.*, in 1879–80, domestic electric lighting was an achievement long sought and ardently hoped for but theretofore unattained. To-day every important town in this and other countries is equipped with thousands of incandescent lamps, in shops, public buildings and dwelling houses, all supplied from a common source. Some mind or minds, some one's ingenuity, or skill, or enterprise, has wrought this change. The problem which had to be solved was one which, twelve years ago, was popularly known as "subdivision of the electric light." It was a different problem from that of the production of a single light from a source of electric energy. It would be too much to contend that this achievement is wholly due to any one invention, or to any one man, but the present invention was at least a notable contribution to the solution of the problem. There were inherent difficulties in both the series and multiple arc system, when applied to extensive distribution to a number of lamps. In 1879 the whole subject of electric lighting had been examined with care by a Parliamentary Commission of Great Britain, at which time the evidence of many prominent scientists served to give some idea of the nature of the difficulties to be encountered. Mr. Edison's plan of using the high resistance lamp with a platinum filament, and of distributing current through it by branches radiating from a common trunk, was known as early as 1879. On January 27, 1880, he patented his carbon filament lamp. He described the general features of his intended system of distribution in an application filed August 9, 1880, and patented March 22, 1881. The present invention is outlined in a caveat filed August 19, 1879, and disclosed in the application for the patent in suit filed August 9, 1880. The difficulties in the way of dealing successfully with electrical energy under the conditions involved in wide distribution arises from the fact that all conductors offer some resistance to the propagation of electric energy, and this resistance occasions the change of electric into heat energy. This conversion takes place throughout any system, but is only useful at the particular points where heat and light are to be made useful and sensible; everywhere else the conversion, though inevitable, is useless, and hence an absolute loss. The problem, as seen by Mr. Edison, therefore was: (1) to concentrate and localize as much as possible the operation of lowering the potential at points where, if useless, it would not affect anywhere the quality of work to be done, and if useful, it would be utilized; and (2) as far as possible to prevent its occurrence in other parts of the system. The ideal mode, theoretically, would be to have conductors of infinite size except at points where obstruction is desired for the production of heat and light; but this is not a feasible remedy, because the cross-sectional area of conductors would necessarily be so large as to involve a prohibitory expense. Moreover, if the whole system be an extended one, and be utilized for consumption throughout, and unless the conductors be so large that no loss in tension ever occurs (which is impracticable) then it is obvious that a variable drop in tension due to variations in the amount of energy translated, will affect very differently, at different times, different lamps in the system. Now Mr. Edison reasoned that if economy of copper is not practiced between any lamps, but only in such parts of the conductors as do not affect the relative candle power of the lamps, then distances may be reached with economy of copper, which are otherwise inaccessible.

The field of the present invention lies between two classes or systems of distribution; one where drop in tension need not be practically considered at all, and the other where the system is so extensive that the size of conductors required to supply it with equal pressures throughout would have to be approximately infinite.

Comparing the second and third, with the first claim of the patent the latter are subordinate in character to the former and introduce special features of construction included under, although not required by, it. The second claim requires a definite small drop in the consumption circuit, and that the drop on the feeder shall exceed that of the consumption circuit. The third claim requires the connection at the feeders to be at a central point on the consumption circuit. The system described and claimed in the patent, is an extended system of electric incandescent multiple-arc lighting, of such dimensions that the distances between the lamps prohibit their supply from one end of a direct circuit, because the drop in tension or the amount of copper required between the lamps would be too great, and also one in which, for purposes of maintaining equal potential at the terminals of all the lamps and notwithstanding the existence of excessive drop in the tension in the system as a whole, that drop is localized where it does not affect the lamps. These characteristics of the Edison system of distribution involve essential characteristics of novelty and are believed to have required the exercise of the inventive faculty for their original production. That the invention is one of great utility is conceded on all hands. The system of the patent in suit was the first practical central station system ever constructed in the world. It was embodied in the New York installation, commenced in the fall of 1881 and opened for operation September 4, 1882, orginally calculated to supply 16,000 lamps. The drop in tension was calculated to be about 15 per cent. on the feeders, and not to exceed 3 per cent. on the mains.

The bill charges that the erection of the infringing central station plant by the defendant was done not only in defiance of the patents of the complainant company, but by taking from the employ of the complainant, and making use of the services of, many employés and experts, whom the complainant had trained in the construction and operation of such plants. When complainant's original *prima-facie* case was a closed in January, 1890, complainant relied upon having proved infringement of the first and third claims, and this was admitted by defendant's experts. Facts were subsequently proved which tended to show beyond question that all three of the claims had been infringed.

The Supreme Court of the United States has commented upon the impossibility of making any satisfactory definition of what constitutes invention. A goal is to be reached, and keen eyes peer in every direction through the mists of surrounding ignorance and uncertainty for any signs of approach to, or the direction of, such goal. He who under such circumstances notably excels his fellows in speed, or who, stepping out of the supposed line of journey, first perceives that it is to be reached by a new, even if only slightly divergent, road, and who thereupon points out the right way, is, in a true sense, an inventor who has promoted the progress of the useful arts. The existing difficulties of the situation, actual or supposed; the mists of ignorance, error or prejudice then obscuring the vision, are to be taken into account in determining whether or not his finding of the true path was only what every one might have done if called upon. In this characteristic of the seeming obviousness of the greatest inventions when once made, they do but resemble the deepest revelations of mental consciousness; as soon as they are stated they are seen to be so obviously true that it is a matter of wonderment that they had not been stated before. In the present instance the problem was not merely that of conveying electricity to a distance and there causing it to be converted into many lights; it was rather to reach and properly supply all parts of a multiple-arc system, some lamps of which were so remote and others so near, that the whole could not be supplied in a direct circuit, and morever to do this without sacrificing substantial equality of potential, and without exceeding practical limits of cost. The remedy lay in a perception of the fact that the distribution could not be practically accomplished without dividing the circuit into two parts.

The question now presented, is whether in the years 1879–80 the means of attainment devised and pointed out by Edison were obvious. A person skilled in the art, at a given time, is perhaps in law presumed to have knowledge of all that had been publicly done in that art up to that time (though as a matter of fact no person with such universal knowledge ever does exist), but it does not follow, therefore, that the law presumes that even persons with the supposed knowledge of all that had been done, necessarily could know what is really true, or what is really erroneous, or could so infallibly distinguish between the true and the false as to be able to combine only what is true, and the best of what is true, so as to produce the highest and best results. Mr. Pope, the defendant's expert, admits that he knows of no patent or publication, prior to August, 1880, which points out the necessity or desirability of locating any drop of tension in excess of a negligible amount, in that part of a system of conductors nearest the generator, and having no lamps connected therewith.

The different prior publications, patents and uses set up as specific defenses are next to be considered. The diagram of Werdermann's British patent, No. 2477 of 1878, was perhaps an attempt to deal with the problem of simultaneously supplying a number of lamps under such conditiens that they would burn at equal candle power. The arrangement is what is known as "reversed parallel," because the position of the return conductor with reference to the first and last bridges is reversed from its position in simple parallel. Werdermann's diagram, which is intended to represent an extended system of distribution, clearly contains no division of the system into feeders and consumption mains, and it is also to be noted that his lamp is not an incandescent lamp. His proposed remedy was, not to limit the consumption circuit to dimensions on which the drop in tension was negligible, nor to divide a large system by points of feeding so that the drop in tension in each part should be negligible, but it was rather the fallacy of creating "equal electrical distances" to each lamp and to enable any sized consumption conductors to be used. Nor was it his idea to use feeders freed from any and all connection of lamps and translating devices. Khotinsky's French patent, No. 107,307 of 1875, was before the Patent Office on the grant of the patent in suit, and was then overruled as a reference. The drawings illustrate an ordinary multiple-arc circuit, supplied at different points by a machine. There is no intimation in the patent that the inventor contemplated any plan of dealing with the difficulties of drop of tension in an extended system; nor that the connections from the machine to the lamp circuit were anything more than the ordinary connections from a machine to a circuit in close proximity therewith; nor that any economy in construction was made possible; nor that any regulation of current with varying numbers of lamps could be facilitated. It gives no consideration or direction which teaches any one how to maintain uniform candle power, or uniform pressure, in an extended circuit. The courts have repeatedly held, that a prior description, in order to invalidate a patent, must be such as to show that the article described in the patent can certainly be arrived at by following the prior description. The general statements of the defendant's experts as to the similarity of the Khotinsky arrangement of circuits to that of the patent in suit, and to the effect that the details of construction specified by the patent in suit would be understood from Khotinsky's patent by those skilled in the art, are abundantly controverted by the evidence of the complainant's experts. Sir William Thomson says, that Khotinsky "does not suggest anything towards the illumination of towns, or the carrying of the electrical energy to considerable distances. He does not contemplate any difference of pressure in different parts of the circuit; there is certainly nothing in any part of his patent which gives any indication towards the solution of the problem discovered by Edison." The testimony of Prof. Chandler and Mr. Jenks is to the same effect. In the British patents of Lane-Fox, Nos. 3988 and 4626 of 1878, and his letter to the London *Times* of December 26, 1878, as expressly admitted by Mr. Pope, defendant's expert, he does not point out any specific arrangement for accomplishing equalization, but merely says that it is to be done by properly arranging and proportioning the conductors. There is in the Lane-Fox patent no scheme for a division of the system of conductors into two parts, one for supplying and regulating the current, and the other for consumption, and the connection of the supply circuit, and the proportioning of the consumption circuit in such a way that there shall be only a negligible drop in tension on the consumption portion. On the contrary, his idea was to use the whole system for consumption, and while probably aware that this would involve a ruinous expense for copper, yet he saw no remedy for that difficulty except that of placing local regulators at each branch, or introducing storage batteries at distant points, and by using an earth return, all of which devices have proven to be wholly impracticable.

The publication in the *Scientific American*, in 1877, illustrates an electroplating apparatus described by Weston as an ordinary electroplating bath. None of the distinguished scientists examined before the British Parliamentary Commission of 1879, appear to have supposed that the secret of proper electrical distribution lay hidden in the every-day practice of an electroplating bath. The analogies to the operation of an electric lamp are so distant, and the structures, consisting of soluble anode, liquid electrolyte, and temporarily inserted cathode, are so totally unlike anything existing in the incandescent lighting art, as to destroy any possibility of treating this compound apparatus as the equivalent of an electric lighting plant. Sir William Thomson says that "there is absolutely nothing in common in the two cases between the respective difficulties and the respective arrangements for overcoming them."

The proof in regard to the use, in distributing systems of gas and water, of what are known as "independent mains," is comprised in a number of early publications and oral evidence in regard to a number of early plants. It may all be summed up briefly, by saying that it appears that for half a century it has been the custom to lead "independent mains" from reservoirs of gas and water to distant consumers, and in some instances to assist overloaded systems by carrying pipes from the reservoirs directly to overloaded points with a view of supplementing the supply at such points. The proposition of the defendant is understood to be, that the known analogies between the laws which govern the flow of fluids and those which govern the so-called flow of electricity, are such that an electrical engineer, in 1880, by the exercise of ordinary skill and knowledge, would necessarily have distributed electricity by a division of the system into consumption and feeder circuits, by proportioning the consumption circuit so that the drop in tension between the several lamps would be negligible, and by bringing the total amount of copper in the system within practical limits, by localizing on the feeders whatever drop in tension was necessary to be incurred to accomplish such economy. The complainant's experts on the other hand contend that the problem was essentially different in the two cases; that the difference between the ponderable bodies known as gas and water and the imponderable something, which we call electricity, are radical; that the laws governing the so-called flow of electricity are different from those governing the flow of gas and water; that the surrounding and interfering conditions are widely dissimilar; that the characters of the conducting systems are unlike, in that one requires only an outflow system, while the other requires an outgoing and return system; that the conditions of economy are very unlike as between hollow pipes and solid conducting wires; and that the incandescent lamp bears no analogy to any device for allowing the consumption of gas or water; hence that the rough analogies which exist between the two systems were not sufficient to teach the electrical engineer that the idea of the so-called "independent main" could be transferred to and adapted to a system of electrical distribution, or that the desired problem of distributing electricity so as to maintain equality of candle power throughout an extended system, with reasonable economy in the cost of conductor, could thereby, or otherwise, be solved. The opinions of the defendant's experts as to the teaching analogies of gas and water distribution, and their effect in vitiating the novelty of Mr. Edison's invention are stated by President Morton and Mr. Pope, but on the other hand the testimony of the witnesses for the complainant, Sir William Thomson, Prof. Chandler, and Messrs. Brevoort and

Jenks, is specifically to the contrary, and the reasons given seem to be satisfactory and conclusive.

The complainant contends that Mr. Edison was the first to deal with an extensive system of distribution, so as to secure uniformity of operation throughout, by the mere arrangement and proportioning of the conductors; the first to establish as the standard of uniformity of pressure on such circuits, the maintenance of equal candle power; the first to supply circuits located at a distance by means of conductors set apart for supplying regulation only; the first to teach how loss of force in reaching distant points with economy could be endured without impairing equality of force where it was to be utilized; and the first to provide a system by which not only uniformity of candle power or pressure could be produced over an extended area, but such uniformity could be maintained under all variations of consumption, because the loss, whether constant or variable, did not affect the consumption.

It is contended by defendant that the patent is void because it covers a necessary and inevitable mode of construction which would naturally be adopted in supplying a small building with electricity from a distant source. This argument sounds plausible, but it is not sound; no one did in fact, prior to 1880, construct any such system. Why should the idea of using the lamps in multiple arc arrangement, and the further idea of supplying such an arrangement from a distant generator, necessarily occur in connection with each other? It requires the connection of those two ideas to make the imaginary case of the defendant. But even if this combination of ideas had actually been made, or such small installation had been actually set up, it is clear that it would have been done without any thought of any problem having thereby been solved of the distribution of electricity over large areas.

It is contended that this invention is a mere matter of engineering and would naturally occur to any engineer. Are not all inventions the result of the working of the law of supply and demand, which, when an invention is needed, stimulates trained minds to work it out? Is not an inventor one who merely hastens the inevitable evolution of thought? The courts have often said that an invention may be made in a flash, but they have never said that it must be so made, or that it may not be made as the result of a thorough and intelligent working out of a problem. The final perfection of all improvements is often removed by only a short space from previous impracticable contrivances. In this, as in all other things, as the proverb says, "Perfection lies in little things, but perfection itself is not a little thing." It is the finishing stroke that counts. The Supreme Court has said "In the law of patents it is the last step that wins."

The defendant contends that the application for a patent, as originally filed, does not contain the invention as now defined; but this is an error. The drawings are the same as those found in the patent as granted, except that some figures have been erased, and the claims originally filed, though more general in phraseology than those now sued on, evidently include the same subject-matter. The effect of the amendment to the specification in its progress through the Patent Office, was merely to eliminate objections based on the generality of the language first used, but not in any way to alter the character of the invention.

It is submitted, therefore, that the feeder and main invention of Edison, was one involving invention of a high class; that it was not anticipated by any constructor, nor found described in any prior patent or publication; that it is clearly infringed as to the first three claims; and that complainant is entitled to a decree.

THE EDISON INCANDESCENT LAMP PATENT—FINAL HEARING BEFORE THE U. S. CIRCUIT COURT OF APPEALS.—II.

ON April 26, General Duncan resumed his argument. He pointed out that whether arranged in series or in multiple arc, the law was true of all translating devices, that the law of high resistance in each individual transmitting device must be observed. He then showed that when lamps were arranged in multiple arc, there might be conditions which required the lamps in one plant to have higher resistance than those in another; in some commercial lamps, the resistance was certainly fifty or sixty times, if not 100 times as great as in others, yet the same law applied equally to them all, viz.:—A high resistance in the translating devices as compared to other parts of the circuit. It seemed to him that there could be no other signification attached to the expression of "high total resistance" in this whole discussion. It would not do to say that a burner had high resistance merely because it happened to be higher than that of some other burner. That was not the test; if that test were to be applied somebody to-day might make a burner of higher resistance than Mr. Edison made yesterday, and then Mr. Edison's burner would become one of low resistance. The root of this matter of high resistance was beyond any such attempted definition, and the explanation lay in the direction he had indicated. Another feature to which he desired to call attention was that the carbon of the modern incandescent lamp was subject to continual deterioration, whether it was called disintegration, evaporation, volatilization, or any other name; from the time a lamp went into service its efficiency continued to run down until its life was gone. The record showed that manufacturers did not care to guarantee a life of more than 600 hours. What was the significance of that fact? There, said General Duncan, pointing to a diagram, are curves plotted from observations by a committee of the Franklin Institute in 1884. Twenty Edison lamps had been tested for 1,000 hours. The curve of candle power showed at the beginning an average of 18.6, gradually decreasing until at the end of the thousand hours it had fallen below 12 candles, a loss of over 33 per cent. Another curve showed that the average resistance of the lamps at the beginning was 136 ohms, while at the end they had risen to 148, some ten or twelve ohms. Now what did those curves signify? This, that in the progress of the tests a change was going on in the carbon. There was less light given off, and there was a disintegration of the carbon whereby its cross-section was diminished, its resistance increased, and the detached particles of carbon were deposited upon the globe producing the blackening which their honors might perhaps have observed in incandescent lamps. There was a disintegration of carbon going on with a consequent loss in illuminating power. It was a gradual process, but a necessary concomitant of the incandescent lamp as made by all manufacturers. Other published tests made by Mr. Fousshe and by Dr. Siemens, were cited in which similar results had been shown. These various pieces of evidence warranted him in asserting that there was no such thing as "absolute stability" of the carbon of incandescent lamps. He used that term advisedly, because Mr. Edison had claimed to have made such a discovery, and had said in his testimony that with great deliberation he had written into his patent, that carbon was absolutely stable when introduced into an all-glass globe from which air and all other gases had been exhausted. Now, he, (General Duncan) contended that there was no such thing as "absolute stability." The stability of carbon in a lamp was a mere relative term. No man had even yet reached that point where he was justified in claiming that he had discovered a method whereby it could probably be made absolutely stable. He ventured to say that this observation would ultimately be found to have an important bearing upon the merits of the controversy. He then referred to a later patent of Edison, in which, giving the public the benefit of his larger and riper experience, he had said that too high a vacuum must not be used, or the carbon would disintegrate too rapidly, and the life of the lamp would be too short.

General Duncan said he would next ask their honors' attention to the patent in suit. Handing to the court a lamp which plaintiff asserted to be a copy of the Patent Office model, he called attention to the fact that the burner, presumably of carbon, was coiled into a spiral. The contact between the burner and the leading-in wires was by means of a cement, moulded around the junction and carbonized in position. He would first invite attention to the second and third claims of the patent. The second claim was for "the combination of"—as it reads—"carbon filaments," (it should read undoubtedly a carbon filament) "with a receiver made entirely of glass, and conductors passing through the glass and from which receiver the air is exhausted for the purposes set forth." The third claim was for "a carbon filament or strip coiled and connected to the electric conductors, so that only a portion of the surface of such carbon conductors shall be disposed for radiating light as set forth." Their honors would notice that the term filament, a pivotal term in the patent and in the whole discussion, was singularly enough a term never known in the art until employed in this patent. Yet the patent contained no attempted definition of the term itself. Notwithstanding the requirement of the law, that in order to secure a valid patent a full, clear and concise description must be given, and the distinction pointed out between the invention and what had gone before, this gentleman had gone to the Patent Office and had used a term, a pivotal term in the patent, absolutely new to the art, and had given no definition of it; had left defendants to guess its meaning if it were possible to do so; had left them in a state of uncertainty that did not enable them to determine what were the respective rights of the parties; what ground had been covered, and what had been left open for the world to occupy without molestation. It was a most significant fact that the definitions of the term which had been given were as numerous as the judges who had undertaken to define it. But notwithstanding it was a new term in the art it had been universally adopted, not only in the shops but in the literature of the art, and whether the burner was the five-thousandth of an inch, or twenty times that diameter, they were all called "filaments" in the popular sense. Examining the text of the specification, he found many other terms employed by Mr. Edison to designate the burner of his lamp; he had referred to it as a "strip"; as "wire or sheet"; as "conductors" and in another place as "threads." He supposed gentlemen upon the other side would contend that the employment of these numerous terms ought to serve as a guide to determine the meaning of the word filament in the claim, but to which one of those terms could they go? Notwithstanding the uncertainty in which the nature of the invention had been left by Mr. Edison by the use of this ambiguous, undefined and novel term, he thought it possible to determine that whatever else it might mean, it had certain limitations imposed upon it, by which plaintiff must be bound. The thing called in claim 2 a "filament" was a burner that must be coiled into a spiral. It was a device whose resistance, when in working order, must be at least 100 ohms, else it could not perform the duty assumed to be put upon the lamp which was the subject of the invention. He thought it also imported a carbon having a high specific resistance due to carbonization pure and simple without any reduction arising from subsequent treatment. Analyzing the language of the claims, General Duncan contended that claim 3 was for a peculiar form of burner, irrespective of the globe in which it was placed, while claim 2 was narrower, and was for putting the burner of claim 3 into a globe entirely of glass from which the air had been exhausted. He then proceeded to show that the method of producing high resistance and still keeping down the radiating surface, was by coiling the conductors. If Mr. Edison had known at the time he made his invention how to manipulate carbon as well as he knows to-day it might not have been necessary to introduce this limitation. The art had progressed wonderfully since October 1st, 1879, and there were to-day processes by which high resistance burners could be secured without resorting to that method, but that was not what Mr. Edison had explained to the world in this patent. He believed Mr. Edison had worked intelligently on that line. He had found it necessary to coil the carbon to secure that high degree of resistance necessary to make the lamp serve in large numbers in multiple arc. He had found that coiling would be conducive to steadiness in the light, and to economy in the operation of the lamps, and then he had come in and said: "My invention consists first, in the burner which is coiled, and secondly,"—the principal thing in controversy herein —"in putting such a burner into a particularly constructed exhausted globe," and he would say here, if that be the construction of the claim, no injunction could go against the defendant. Defendant's burner was not coiled; nor could it have been used in large numbers in multiple arc, with any method of distribution of current known to the art at the date of its issue. He should have occasion later on to refer to an application filed in the Patent Office just after the issue of the patent now before the court. A controversy arose in the Patent Office as to the nature of the invention covered by the patent in suit. It had been found necessary to draw a distinction between the invention of the patent in suit and the invention covered by the then pending application, in order that Mr. Edison might secure, through the medium of that pending application, a broad claim such as plaintiff asserted to be the proper interpretation of the patent which they had brought into court. Furthermore, a month and a half after he had filed the application of the patent in suit, they found Mr. Edison filing a caveat in which he had given an exposition of the philosophy of coiling the burner, and had insisted that coiling was a necessary means for securing that conjunction of high resistance with small radiating surface necessary for the distribution of lamps in large numbers in multiple arc. Whatever, therefore, Mr. Edison may have discovered at a date later than November 4, 1879, when he made application for this patent, he certainly at that time regarded the coiling of the burner as a *sine qua non;* he had not only said in terms in claim 3 that it was to be "coiled," but in laying the foundation of claim 2 he had said the invention had consisted in putting such a burner into a globe of a certain character. Now he (General Duncan) conceived it to have been one of the fundamental errors made by the circuit court; that of refusing to find that coiling was a constituent of the second claim. The learned judge had said that coiling was only an alternative form, and not a constituent of the second claim, but the reason which had been assigned for the support did not support that conclusion. The court had said: "It may be that in the haste which has always seemed to characterize Mr. Edison's efforts to patent every improvement, real or imaginary, which he has made or hoped to make"—which he thought a very excellent characterization of Mr. Edison's methods of patenting supposed inventions—"he had not stopped to reflect, when he framed his application for the patent, that the filamentary burner would do its work just as well uncoiled as coiled, provided the same length and cross-section were used." The fact was, a burner would *not* do its work just as well uncoiled as coiled, provided the same length and cross-section were used. It was impossible that it should be so, yet that was the reason Judge Wallace had given for finding that coiling was not a constituent of the second claim? If his honor had understood that point would it not have been logically necessary for him to have concluded that the coiling was a constituent of the second claim; and therefore that the defendant was free? Another limitation which defendants thought must necessarily result in claim 2, was that the thing called therein a "filament" was a burner having a resistance of not less than 100 ohms when heated by the passage of the current. An analysis of the patent showed that Mr. Edison's idea was to organize a lamp that would allow a practical subdivision of the electric light. He had criticised the older lamps because of their low resistance, and had said that for this reason they could not be used economically in great numbers in multiple arc. He proposed to employ a filament of carbon, which might he so used. He had not told us what a filament was, but they had learned from the patent itself that the thing he had been talking about by this unknown term was something having a very high resistance; high enough to permit a large number to be used in multiple arc. How high must that be? If the patent did not tell them, they had a right to go to the contemporaneous utterances of the man who made the invention. The lowest resistance mentioned in the patent in connection with the curious term "filament" was 100 ohms. Did he intend that to be the lowest limit? They thought it was. Mr. Edison had testified in 1881, referring to certain experiments just about the time this invention had been made: "What we desired at that date, and had concluded as the only possible solution of the subdivision of the electric light was that the lamp must have a high resistance, and small radiating service, so as to be capable of working in multiple arc commercially, and our calculation showed us that lamps must have at least 100 ohms resistance to compete successfully with gas." We find Mr. Edison in other statements declaring again and again that the burners must have at least 100 ohms. Is not that limitation then fairly embodied in this term "filament?" If it be such a limitation upon the second claim then two of the three lamps made by the defendant were not within the claim.

THE OLD SUIT OF THE NEW YORK ELECTRIC LINKS CO. SETTLED.

THE United States Supreme Court has affirmed the judgment by which the Court of Common Pleas of New York refused to grant the New York Electric Lines Company a mandamus to compel Rollin M. Squire, then Commissioner of Public Works of New York City, to give the company a permit to make an excavation in the streets for the purpose of laying underground wires. An act of the New York Legislature authorized the company to construct lines along the public highways, and in April, 1883, the common council of New York gave the company permission to lay its wires through the streets of the city. The company filed a map of its proposed location in accordance with the requirements of the city ordinance, but took no steps toward laying its wires until July, 1886, when it applied to Commission Squire for a permit to make excavations. In the meantime, the act creating the New York Electric Subway Commission had been passed, and to this commission was given authority to approve all plans for underground conduits, and the permit was accordingly refused the New York Electric Lines Company.

The company made the claim that as it had accepted the franchise granted it, the refusal to give it a permit under that act constituted an impairment of the obligation of its contract. The Court, in an opinion by Justice Lamar, read by Justice Blatchford, holds that the contention is not well founded.

Letters to the Editor.

HIGH AND LOW SPEED ENGINES IN RAILWAY WORK.

I HAVE been greatly interested in reading the article by Charles W. Wason, in your issue of April 27, on "Comparative Tests of High and Low Speed Engines in Electric Railway Work." As Mr. Wason says, the difference in coal consumption in favor of low-speed engines is not as great as advocates of this type of engine have been wont to expect and claim; and I would submit, that if the test could be brought to more exact equality of conditions, as regards temperature of the feed water and the evaporative efficiency of the boilers, this comparative difference would be much reduced.

Taking the figures given for the temperature of the feed water, it appears from a calculation of the amount of heat required to raise the total feed water through the range of temperature represented by the difference, that the amount of fuel per electrical horse power would be reduced .25 pound. Had it been possible to secure the same evaporation per pound of coal in each test, the decrease in the amount of fuel per average electrical horse power per hour would have been about 8 per cent., equal to .5 pound of coal. This would make the difference still remaining in favor of the low-speed engines only equal to .43 pound of coal per electrical horse power per hour.

Taking into consideration the increased floor space occupied by low-speed engines and counter-shafting, the greater cost of the installation, the extra belts, bearings and details of apparatus requiring attention, it would appear that the low-speed plant would have little or no advantage, practically, over a plant equipped with first-class high-speed engines directly belted to the generators.

I do not wish to be understood as citicising in any way Mr. Wason's tests, but simply as inviting more favorable consideration of the high-speed engine for this service.

THOS. G. SMITH, JR.

CINCINNATI, OHIO.

THE CONSTRUCTION OF THE LONG-DISTANCE TELEPHONE LINES.

Referring to Mr. Herbert Laws Webb's article in The Electrical Engineer of May 4 and 11, I think that gentleman could add still more interest to his generous contribution of telephonic literature to the technical press by giving some information on the following points, namely:

How is it that conversation can be satisfactorily carried on over a wire from Newark to Boston *via* Pittsburgh, Buffalo and Albany, upwards of a thousand miles in length, having a *K. R.* of over 157,000 for the entire loop, when the rules laid down by Preece and H. R. Kempe state that the *K. R* of a loop divided by 4 should not exceed 10,000 to insure good speaking?

On page 449 is a cut of a long-distance telephone pole, the top end of which is out of sight, and supposed to carry 50 or more wires. What engineering rules are observed as to the length, diameter of base and top for vertical and lateral stresses, including wind pressure on the surface of pole and wires?

Mr. Webb speaks of the wires as being "tautly drawn," but no data is given as to the sags allowed at different temperatures and the ratio between the tension of the wires in coldest weather, and their breaking strain; and what kind of splice has been found to preserve a good electrical contact in all situations and at the same time approach as nearly as possible the normal breaking strength of an unspliced wire?

I cheerfully recognize and applaud all efforts at good substantial work in both the telephone and telegraph field, and believe it is to the interest of the proprietors to have such undertakings carried out under the best engineering rules in the most substantial manner; yet I fear Mr. Webb has allowed his enthusiasm to lead him into an unwarranted belittlement of his neighbors, not quite appropriate to the columns of the technical press. He will no doubt realize this when he reflects upon the miles upon miles of Long-Distance telephone lines that were hopelessly prostrated in January, 1891, in New York, Connecticut and New Jersey, and of the comment it excited at the time among electrical engineers. Even in the streets of New York City, poles fell into people's windows and across the streets in all directions; and yet Mr. Webb tells us that the most thoroughly scientific electrical engineering is exemplified in the most striking manner in the Long-Distance telephone system.

F. W. Jones.

New York, May 11, 1892.

Literature.

Dynamo-Electric Machinery; A Manual for Students of Electrotechnics. By Silvanus P. Thompson, D. Sc., B. A., F. R. S. Fourth edition, enlarged and revised. *New York*, Spon & Chamberlain, 1892. 864 pages. 5½ by 8½, 29 plates. Price $9.00.

We do not go beyond the bounds of conservative estimate when we characterize the "Dynamo-Electric Machinery" of Prof. Thompson as the work, above all others, to which electrical engineers have long looked for a record both of the art and of the theory underlying the construction of such machinery.

Some ten years ago, in his Cantor lectures, delivered before the Society of Arts, Prof. Thompson gave an excellent résumé of the general principles underlying the construction of dynamos, and with this as a basis he subsequently elaborated the work of which we now find before us the fourth edition. It would be, indeed, a work of supererogation to attempt, at this late day, to give a general review of this well-known and universally employed manual, but the volume before us contains much new matter, and has, we are glad to note, been given a thorough overhauling, with the result that it presents a far greater harmony in the treatment of its subject-matter than is to be found in the older editions. We notice particularly that Prof. Thompson, in conformity with the views now generally prevailing among electrical engineers, has drawn less and less distinction between dynamos and motors, in the treatment of the problems involved in their respective designing, and has, on the contrary, treated the subject more particularly from the standpoint of action and reaction between a wire carrying a current and a magnetic field in its neighborhood. Being a work intended more for the practical worker than for the mathematician, the author has wisely so framed it that it may be considered to be an exposé of physical and experimental theory, in contradistinction to the mathematical, but he has not refrained from employing, where necessary, algebraical and graphical methods. Thus, in order to impress at once upon the reader the physical theory of the dynamo, the author brings out as an illustration Fleming's now well-known rule of current flow, represented by the thumb, index and middle finger, and builds up from this the actions which take place when a conductor passes through a magnetic field. Even at this point in the theory the author introduces examples taken from actual machines, so as to impress upon the student the manner of employing the formulas and symbols. He has added much, also, to the chapter on the actions and reactions in the armature, and has given special attention to the cross-magnetizing action which takes place and which is shown very clearly by a number of diagrams illustrating these various actions. Taking all these actions into consideration, the author vouchsafes the statement that the ideal dynamo of the future for constant pressure work will have but one turn of wire to each section; it will have practically no lead at the brushes will not spark, and its internal resistance will be practically nil.

The author then takes up the mathematical action and reaction and furnishes numerous examples and methods of calculation to obtain given currents or torques in dynamos and motors. Magnetic principles and the magnetic properties of iron and magnetic circuits, and the working theory upon which the modern dynamo is based naturally come in for a large share of attention, in which the author has introduced the results of the latest work of Ewing, Hopkinson and others. The application of these researches to actual construction is shown, and we are pleased to see much of the older matter in former editions omitted in the present. The author treats very thoroughly the various forms of field magnets, and then passes on to the elementary theory of the dynamo, and the discussion of the characteristic curves, which leads up naturally to the construction of constant potential machines. The chapter on winding of armatures and the theory of connections is of special interest, as it brings out the special methods employed, including not only the older ring and drum types of winding, but also those of more modern disc types. The succeeding chapter on the mechanical construction of dynamos, the descriptions of constructing the commutators, brushes and brush holders, of attaching the iron core to the spiders or driving flanges, etc., and a variety of other details of like nature all add to the practical value of this part of the work. We notice that among the methods of applying carbon brushes, the author illustrates a practice, evidently of English origin, in which the brushes are said to rake in a direction opposite to the rotation, so that the end pressure may be greater when running. We are not informed as to the manner in which the brushes so set wear, nor as to their noiseless properties—if, indeed, they can be anything but noisy and chattering. The particular brush illustrated is designed for use on the mining motors. Minor mechanical points in the design and construction of dynamos also form the subject of a short and very valuable chapter, in which these details relating to the most successful machines are given.

Perhaps the student, who is looking about for a guide to the application of the rules and formulas laid down, and which form the subject of discussion in many valuable papers in the transactions of electrical societies, will be most interested in the chapter devoted to the elements of dynamo design and calculation of winding. In this the author, with the aid of numerous examples, shows how the formulas are applied to calculate the volts generated in the armature, the current flowing in the armature and field, the gauge of wire for both, the magnetic flux through the armature, the cross-section of iron necessary in both the field and armature, and a variety of kindred points, all requisite to the design of an efficient machine.

Arc lighting dynamos and examples of modern machines of various types then follow. In the latter chapter the author gives a brief description of the Edison dynamo, 1888 type, the one now in general use. The author states that the field magnet is of cast iron. This is an error, as both the magnet cores and the yoke are of wrought iron, the pole-piece alone being of cast iron.

While, as above stated, the subject has been treated from the broad standpoint of action and reaction between armature and field magnet, and thus made to include both the dynamo and the motor, the author has very wisely introduced into his chapter on electric motors much new matter tending to elucidate some of the points which must be considered in the design of electric motors; and the new illustrations introduced will go far towards clearing up the subject in the minds of beginners.

The principles of alternate currents and their application to the modern alternating dynamos form subject matter of Chapter XXII, and this is followed by a chapter on alternate current motors, in which the latest multiphase of rotatory field machines are described and discussed with the aid of excellent diagrams. Alternate current transformers are then taken up by the author and their theory and method of construction described, with special reference to actual examples as exhibited in practical transformers. Regulators for dynamos and the testing of dynamos and motors for efficiency may be considered to end the part relating to the theory and construction; to these the author has added a chapter on the management of dynamos, containg general instructions for their use, and embodying much of the author's famous paper on the "Diseases of Dynamos."

The work throughout is copiously and most uniformly well illustrated, so that the reader gains an accurate knowledge of the machines and principles described. The value of the new work is also enhanced by a large number of plates showing the details of construction of a great variety of new machines all drawn to scale, and thus offering a valuable guide to the designer both of continuous and alternate machinery. In a work of this character, devoted more particularly to the exposé of principles and descriptions of machinery, much can be done by an author to arouse interest in a subject, which would hardly be characterized as popular; but the felicitous style of putting things, for which Prof. Thompson is so well known, will, we are sure, continue to make the work before us in the future, as it has been in the past, not only the most complete but the most popular extant on this subject. If Prof. Thompson had done nothing else, this invaluable book would serve as his enduring monument.

College Notes.

SCHOOL OF MINES, COLUMBIA COLLEGE.

THE two year post-graduate course for the degree of electrical engineer is outlined in the Circular of Information of Columbia College for 1892–3. Candidates must pass entrance examinations in mathematics, mechanics, physics, chemistry, and drawing, and the curriculum provides for very thorough instruction in the general principles and theory of electricity as applied to lighting, the generation of power, telegraphy, telephony, etc. In addition to this the course includes a large amount of mechanical engineering, workshop practice and laboratory work, and closes with the customary thesis upon some special subject assigned.

Society and Club Notes.

FRANKLIN INSTITUTE.

AT the last meeting of the Electrical Section of the Franklin Institute the by-laws were amended so that the regular meetings would occur on the fourth Tuesdays of each month at 8 p. m. excepting in July and August. This month however there will be a meeting on Tuesday, the 31st, at which time papers will be read by Mr. Paul A. M. Winand, Prof. Edwin J. Houston and others.

THE FORMATION OF THE MASSACHUSETTS ASSOCIATION FOR SUPERINTENDENTS OF STREET RAILWAYS.

MR. GEORGE A. MURCH of the Worcester, Leicester & Spencer Electric Railway issued invitations to the various street railways of Massachusetts requesting their attendance at an informal dinner held at the Massasoit Hotel at Spencer, on Tuesday of last week for the purpose of organizing a State association for the superintendents of street railways. The party met together in Salem Square, Worcester, where a special car was awaiting to take them to Spencer. About thirty-five gentlemen were present and a very enjoyable trip was made from Worcester to Leicester where an opportunity was afforded the visitors to visit the new station. This station has been running now for about a year and has been extremely successful. The generators are of the Thomson-Houston type and are operated by a large Corliss engine manufactured by C. J. Cooper & Co., of Mt. Vernon, Ohio, and arrangements are now being made to duplicate this plant. Immediately adjoining the station are situated large, well-ventilated car shops and the whole equipment was eagerly inspected by the visitors. The trip was then continued to Spencer where Mr. Murch had a good dinner provided for the benefit of the guests at the Massasoit Hotel. After dinner there were several interesting speeches by the various members in favor of establishing the association, after which the association was formally organized with the following officers: President, Geo. A. Murch, Leicester; vice-president, B. J. Weeks, Quincy; secretary and treasurer, F. G. L. Henderson, Newton. It was voted that the initiation fee be $5 and that all railroads becoming members be assessed that amount. It was voted that the secretary notify the superintendents of all street railways in the State of the formation of the association. The next meeting will be with B. J. Weeks of Quincy and subject to the call of the secretary.

Mr. George A. Murch, president of the association, has had a large experience in street railways in Salem, Mass., Malden, Mass., and Waterville, Me., and elsewhere. He has a made a success of the road which he now represents and will undoubtedly fill the position of president with energy and care. The following gentlemen were present: Geo. A. Murch, supt. W. L. & S. Street R. R.; H. E. Bradford, supt. Marlboro Street R. R; J. E. Sewell, supt. Woburn street R. R.; N. E. Morton, supt. Merrimac Valley Street R. R.; J. J. Hennesey, supt. Framingham Street R. R.; Wesley Wentworth, supt. East Middlesex St. R. R., Malden; J. E. Bigelow, supt. Worcester & Shrewsbury St R. R.; F. Lanoir, supt. Electric Dept. Worcester Consolidated St. R. R.; H. C. Page, supt. Newburyport & Amesbury St. R. R.; M. A. Carter, supt. Attleboro, No. Attleboro & Wrentham St. R. R.; F. G. L. Henderson, supt. Newton St. R. R.; Hon. Samuel Winslow, supt. Worcester & Millbury St. R. R.; B. J. Weeks, supt. Quincy St. R. R.; S. S. Heywood, Salem St. R. R.; R. Sennete, North Carolina; Chas. Page, Toledo, O.; R. E. Bradford, Providence, R. I.; R. E. Morton, Lawrence; C. E. Smith, Boston; H. J. Newton, Worcester; Edwin Watson, J. B. Gorman, W. S. Whittemore, Leicester; O. A. Freeman, Geo. F. Madison, Spencer.

ELECTRIC TRACTION AT THE PROVIDENCE COMMERCIAL CLUB.

THE influential organization known as the Providence Commercial Club, gave its closing banquet for the season at the Narragansett Hotel, Providence, R. I., on May 14th, when the subject for post-prandial discussion was "The Electric Railway in its Relation to City Life." About 100 of the leading bankers, merchants and manufacturers of the city and vicinity, including Governor-elect Brown, sat down, with president Watson at the head of the table. A paper on the subject-matter was read by Mr. T. C. Martin, and addresses were also made by Mr. H. M. Whitney, president of the West End Road, of Boston; Prof. Elihu Thomson, and Mr. Oscar T. Crosby, the head of the railway department of the Thomson-Houston Co. Mr. Charles A. Coffin, president of the new General Electric Co., was also present and was to have spoken, but had unfortunately to leave by an early train for Boston. Each of the speakers took up the topic from a different standpoint, and the hearty reception given their remarks by this representative audience showed that electric traction has gained the day in Providence. Among those present were Messrs. Phillips and Sawyer, of the American Electrical Works; Mr. Fenner, of the New England Butt Co.; Mr. Marsden J. Perry, of the Narragansett Electric Light Co.; and Mr. White, of the Providence Telephone Co. After the banquet, the speakers of the evening were entertained by President Watson, Secretary Field, and Mr. Gardiner C. Sims, at the Hope Club.

ELECTRIC RAILWAY WORK IN BROOKLYN.

THE ATLANTIC AVENUE RAILROAD COMPANY, of Brooklyn, is rapidly pushing forward the preliminary work of electrical construction. The power station will be located on the Gowanus Canal, between First and Second streets, and will cover an entire block. There will be a frontage on the canal of 200 feet, and 630 feet on a lateral basin. The boiler equipment will consist of three batteries of Babcock & Wilcox boilers, each battery comprising two 250 h. p. boilers. Each boiler will be 23 feet long, the tubes will be one-eighth inch thick, and will rest on extra heavy shelves. Four Corliss tandem compound condensing engines have been ordered; one of 350 h. p. and three of 500 h. p.; which latter will be adopted as the unit for future work; the station having been designed for an ultimate capacity of 5,000 h. p. The fly-wheel of the largest engine will be 60,000 lbs. weight. One condenser and two air pumps have also been ordered, to be run by a smaller engine. Three different kinds of rail are to be laid; that manufactured by the Lewis & Fowler Girder Rail Co., Duplex Street Railway Track Co. and the Pennsylvania Steel Co. Samson bridge joints, made by the Tramway Rail Co., of Pittsburgh, will be used with the last-named rail. Ties will be laid 30 inches between centres, of 5 x 9 Florida yellow pine and Connecticut white oak.

The tubular style of poles, with shrunk rings at each joint, will be used; mainly 28 feet long. They will be furnished by Wallace & Co., of New York. Most of the overhead construction will be of span wires; an exception being made as to part of Ninth avenue, where the poles will be placed on one side of the street, with a 15-foot bracket extending over both tracks. This is practicable at this point, as the tracks are not in the centre of the street, but more to one side.

An order has been given for 50 cars, to be furnished by the St. Louis Car Co. They will be 27 feet in length; the body being 18 feet 6 inches. They will be finished inside with mahogany and three-ply bird's-eye maple, with beveled-edge mirrors and bronze trimmings. Peckham's flexible, non-oscillating motor trucks No. 4 B will be used. It is expected that a portion of the road will be in operation early in July. The first motor equipment will consist of 100 30 h. p. Westinghouse motors—single reduction The company have also ordered two 400 h. p. generators and two 700 h. p. generators (Westinghouse) making a total of 2,200 h. p.

A MASTER ELECTRICIAN FOR THE N. Y. NAVY YARD.

A PRELIMINARY examination is to be held at the New York Navy Yard, on May 31, for filling the new position of master electrician in the Equipment Department. The salary is to be $6 per day. The position is open to all comers who are citizens of the United States, and is one requiring ability to lay out work and to get it done. Applications should be addressed to the Commandant, Navy Yard, New York, not later than May 28.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 3, 1892.

Alarms and Signals :—

Electrical Annunciator, F. W. Steeg, 473,975. Filed Oct. 24, 1890.

Enables an indicator whose position has been changed by a call to be restored to normal position by itself without interfering with any other indicators.

Station-Indicator, J. H. Dean, 474,001. Filed Dec. 21, 1891.

Has for its object to provide a reliable and automatic indicator for electric street railways which will operate positively and will not get out of order.

Conductors, Conduits and Insulators :—

Insulator, O. F. Goodrich, 474,319. Filed Dec. 29, 1891.

Comprises a body portion of insulating material and two staples having their ends embedded within the insulating body and their loop portion extending from the outside.

Distribution:—

System of Electrical Distribution, W. H. Elkins, 474,166. Filed July 11, 1891.

Employs a plurality of independent circuits each comprising armature coils connected with the adjacent coils and adjacent segments of the commutator and which are common to all the circuits as the armature revolves but wholly in one circuit while operating.

Dynamos and Motors:—

Apparatus for Maintaining Constant Speed in Motor Mechanisms, J. W. Gibboney, 474,008. Filed Sept. 25, 1890.

Consists in providing mechanisms to be controlled with an electric retarding device in which the energy consumed is varied by controlling its breaking effect in correspondence with the driving power required.

Regulator for Dynamos and Motors, W. H. Elkins, 474,165. Filed Feb. 6, 1890.

Employs three sets of commutator brushes placed at successive points around the commutator, the intermediate sets being fixed and the other two movable, and automatic mechanism for lifting the latter.

Electrical Motor Mechanism, S. E. Mower, 474,328. Filed May 21, 1891.

Employs a gearing of sprocket wheels and chains.

Lamps and Appurtenances :—

Electric Arc Lamp, C. A. Pfluger, 473,955. Filed July 16, 1890.

Employs two distinct gravity clutches, a main circuit magnet working solely upon one clutch, a stop to throw it out of operation, and a derived circuit magnet to actuate the other clutch and regulate the arc.

Electric Arc Lamp, C. A. Pfluger, 473,956. Filed Nov. 13, 1890.

Provides convenient means for conducting the current to the upper carbon and for cutting out the lamp.

Electric Lamp Hanger, E. Dills, 474,003. Filed Sept. 8, 1891.

Consists of a spring-actuated drum having a flexible cord wound upon it and acting in the same manner as a Hartshorn shade roller.

Electric Arc Lamp, W. B. Luce, 474,091. Filed Aug. 8, 1891.

Employs a single magnet to effect the double purpose of a lifting and a field magnet.

Electric Arc Lamp, A. L. Shepard, 474,266. Filed Aug. 6, 1891.

A lamp whose regulation is controlled by coils in series with its arcs so that while keeping the current constant it will absorb any excess of potential or compensate for diminution of potential below the normal.

Miscellaneous :—

Solenoid and its Electrical Connections, H. H. Hosford, 473,929. Filed June 3, 1891.

Provides means for shifting the position of the magnetic poles of a solenoid without making and breaking the energizing current and without injurious sparking at the contact points.

Electric Clock Motor, A. Reckenzaun, 473,960. Filed Dec. 16, 1889.

Has for its object to produce constant motion upon a spindle and to eliminate sparking at points of contact.

Electric Resistance Box, A. Wirsching, 474,073. Filed Mar. 18, 1891.

Employs two frames having the inner faces provided with guideways, spacing blocks of insulating material, fitting into the guideways, and a wire wound in spiral layers between the spacing blocks.

Heat-Regulating Device, A. B. Morse, 474,139. Filed Apr. 21, 1891.

A thermostat having a contact arm moving between two contacts controlling the regulating mechanism and having a safety contact also in circuit with said mechanism.

Thermostat, A. B. Morse, 474,140. Filed Apr. 28, 1891.

Similar to No. 474,139.

Thermostat, L. G. Rowand, 474,149. Filed Oct. 7, 1891.

Employs a fusible solder adapted to allow contact to be made when a certain temperature is reached, thus closing the circuit and sounding an alarm.

Regulating Propellers of Vessels, A. Hellinger, 474,169. Filed Jan. 16, 1891.

An electrical marine engine governor.

Torpedo Launching Apparatus, J. B. G. A. Canet, 474,291. Filed June 9, 1891.

An electric firing mechanism for torpedo launches, etc.

Railways and Appliances:—

System of Electrical Conductors, C. J. Kintner, 473,932. Filed Apr. 18, 1890.

Employs tubular archways of conducting material electrically connected to earth in combination with a concentric conductor whose outer wires are electrically connected to the archways.

Modes of Arresting Electric Locomotives, S. H. Short, 474,031. Filed March 10, 1891.

Provides means of checking the speed of electric cars without employing the current from the trolley line. See THE ELECTRICAL ENGINEER, May 11.

Trolley Wire Circuit Breaker, J. M. Andersen, 474,037. Filed Nov. 11, 1891.

Consists of a non-conducting body having circuit terminals attached near its ends and an independent conductor attached to the non-conducting body and out of contact with the circuit terminals.

Insulating Support for Electric Railway Wires, A. A. Shobe and W. Embley, 474,049. Filed Oct. 29, 1891.

A jointless conductor in which the several lengths of wire are united end to end by being brazed, soldered or fused instead of being united by sliding joints.

Conduit Trolley, J. J. Cosgrove, 474,218. Filed June 3, 1891.

A trolley that may be easily adjusted vertically in order to pass any obstruction.

Bicycle Electric Car, E. M. Boynton, 474,331. Filed April 20, 1891.

A car suspended from the motor and entirely independent of it so that the motor may perform the slight undulations inseparable from running on any kind of road without imparting its motion to the car.

Switches and Cut-Outs :—

Electric Switch, J. J. Wood, 474,050. Filed Nov. 3, 1891.

A quick-break switch intended to reduce the flashing to a minimum and render the cut-out absolute.

Telephones and Apparatus:—

Telephone-Exchange Apparatus, J. J. Carty, 473,911. Filed Nov. 25, 1889.

Requires no generators at the subscribers' stations and no individual annunciators at the central office.

Telephone Switch, C. E. Scribner, 473,966. Filed Aug. 19, 1884.

Provides means whereby the bells of any two subscribers may be shunted and their telephones brought into circuit automatically by the operator at the central office as he connects the lines.

House Telephone System, C. E. Scribner, 474,067. Filed Nov. 22, 1889.

Relates to metallic circuits and apparatus for house telephone work and to a battery having each of its poles carried to each of the different stations and so arranged that one station may signal to any other.

Telephone Receiver, A. T. Collier, 474,214. Filed June 30, 1891.

Employs two diaphragms, each placed between two magnet poles and having an ear-piece or mouth-piece connected with the air chambers between the diaphragms and the adjacent ends of the inner magnets.

Speaking Telegraph, T. A. Edison, 474,230. Filed April 27, 1877.

Claim 1 follows:

In a speaking telegraph transmitter the combination of a metallic diaphragm and disc of plumbago or equivalent material, the contiguous faces of said disc and diaphragm being in contact.

(*See* THE ELECTRICAL ENGINEER, *May* 11.)

Speaking Telegraph T. A. Edison, 474,231. Filed July 20, 1877.

Claim:

In a telegraphic apparatus operated by sound the combination with the diaphragm of one or more contact points of plumbago or similar inferior conductor in the electric circuit whereby the rise and fall of electric tension is proportionate to the pressure exerted upon the said point or points by the diaphragm.

(*See* THE ELECTRICAL ENGINEER, *May*, 11.

Speaking Telegraph, T. A. Edison, 474,232. Filed Feb. 18, 1886.

Claim:

A spring forming or carrying one electrode of the circuit of a telephone and constantly pressing against the other electrode and diaphragm to maintain the required initial pressure between the electrodes and yield to the movement of the diaphragm,

(*See* THE ELECTRICAL ENGINEER, *May*, 11.)

Telephone-Circuit, H. V. Hayes, 474,323. Filed Jan. 13, 1892.

Two telephone circuits each extending from a sub-station to the same central station and closed through a section of conductor common to both and including a battery having an induction coil interposed between it and one of the conductors of the said circuit, the two helices being included in the two circuits respectively.

ON THE THEORY OF THE AUTOMATIC CONTACT-BREAKER.[1]

BY V. DVOŘÁK.

THE author points out that in the original theory of the spring cut-out (the inaccuracy of which was indicated by Koppe) the effect of the electromagnet on the keeper, during the return to the original position, is entirely overlooked, and its attraction is only considered when the keeper is in the position of rest. Since the effects of the actual attractions referred to must be equal and opposite, they can contribute nothing towards the maintenance of the vibrations, supposing that we neglect other important circumstances. The other ways in which the vibrations of the hammer can be affected will now be investigated. They include the retardation of contact, self-induction, the influence of the iron, the dimensions of the core and hysteresis. A complete theory of Wagner's hammer can then be constructed. The curve formed by the increasing current on making contact can be represented by two incomplete sine curves differing by $T/4$ in phase. The first represents the force which is proportional to the distance from the position of equilibrum, and is in operation only during the movement of the keeper from this position up to the magnet and back again, that is during half a vibration. It can have no influence on the maintenance of the vibration which is kept up by the second curve differing in phase by $T/4$. It is this, therefore, that has to be attended to in the winding in order to make the amplitude of the vibration as great as possible. With a specially constructed Wagner-Elsass hammer, which depended on the torsional vibration of an elastic wire, an approximate determination of the energy necessary to maintain the vibrations was arrived at. The result proved that such a hammer must be regarded as an extremely inefficient motor, as approximately only about 1 per cent. of the energy was applied in maintaining the vibrations.

The most important conclusions are as follows : Owing to the small amount of energy requisite for maintaining the vibrations, the resistance of the cells must be kept quite low. Also the resistance of the magnets must not be too great, as this does not conduce to reliability and powerful action of the bell. As to whether the design could be best improved by the use of a shunt or an extra current circuit (in large bells) or a closed secondary coil, the author does not decide. If the circuit-breaker is to be made specially powerful (*e. g.*, for acoustic purposes), the former means can be used with advantage; in particular, the ratio of the coefficient of self-induction to the total resistance must be given a suitable value, and this must be considered in determining the number of ampere turns.

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[1] *Wied. Ann.*, *Vol.* 44.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The public always has an ear for argument and an eye for bargains.

WADDELL-ENTZ APPARATUS IN THE NEW MAIL AND EXPRESS BUILDING, NEW YORK.

THE NEW *Mail and Express* BUILDING, in which the offices of THE ELECTRICAL ENGINEER are situated, when fully completed will be one of the best electrically equipped buildings in the country. The Waddell-Entz Electric Co., of this city, have just been awarded the contract for installing four 75 h. p. direct-connected dynamos of their multipolar type which will serve as the generating plant for furnishing current for lighting and motor work. In addition to the generators they will install no less than 20 motors of all sizes from 40 h. p. down. These will be employed to drive the *Mail and Express* printing presses, and stereotyping machinery, for ventilation and other purposes.

"KERITE" IN NEW QUARTERS.

TIME-HONORED, by being about as old as the electrical business itself is, and having by its many virtues given to not a few electrical inventions their first hopes of success, "Kerite" still pursues its way and there is no reason why fifty years hence some journalist of the time to come will not be singing its praise in the confidence that he can put it more than "pretty strong" without fear of contradiction. While we may not assist at the centennial of this famous insulation, which like the stream immortalized by Tennyson sees a good many human entrances and exits in the electrical field, we shall be only too glad to attain a hale and hearty old age such as it may claim, and like it, be as good as ever after years of strenuous test and trial. During the last few years "Kerite" has done more than hold its own, and has pushed for new fields, keeping pace with the advance of the business; and even when other wires have been used its proprietors have been magnanimous enough to sell "Kerite" tape to patch up leaky places in them. Owing to the growth of the business, the management have lately been enlarging their facilities, and they have now also taken new offices, by moving into the fine new *Mail and Express* Building, 166 Fulton street and 203 Broadway, where they have secured very handsome and commodious quarters on the third floor, overlooking the turf and tulips of St. Paul's churchyard. Another important change that has been made is that by which Mr. W. R. Brixey, who has so long managed the factory with notable success, will also bring his energy and push to bear on the general direction of affairs for Mrs. Day at the New York headquarters. Mr. Brixey will divide his time between Seymour and New York, and is already buckling down with great vim to these double duties. "Kerite" is more than ever to the fore and hangs its banner on the outer wall and its wire on the inner of many of the modern buildings going up all over the country, besides being used more freely year by year in the older telegraph and telephone industries.

THREE DAYS AT NIAGARA FALLS.

THE West Shore Railroad is to run a special excursion Saturday, May 28, 1892, to Niagara Falls, and Buffalo. Tickets will be good going only on special train leaving West Shore station on above date and good for return passage on any regular train on or before May 31, 1892. This trip is of special interest to electrical people just now in view of the work going on in the great hydraulic tunnel.

WHY NOT TAX THE CURRENT AS WELL?

WE are confident that a recent importation of dutiable merchandise at Jupiter, Fla., has not escaped the vigilant eye of Assistant Secretary Spaulding, who writes the decisions in which the Treasury Department interprets and applies the provisions of the McKinley tariff. We refer to the landing at Jupiter of the American end of the new telegraph cable from Nassau. The law with respect to imported goods of this kind has already been interpreted and applied by Mr. Spaulding. As soon as the American end of the telephone cable from the Canadian town of Windsor emerged from the water at Detroit a few months ago, the watchful Assistant Secretary promulgated a decision that it was clearly dutiable and must be taxed under the law of McKinley. The decision has been published by the department, and so far as we know has never been reversed. The American end of the Nassau cable was landed at Jupiter on Saturday last, and the British steamer *Westmeath*, after doing the work, slipped away in the darkness of the following night. The protruding end of this cable should be appraised at once, and the full duty should be exacted.—*New York Times*.

THE FORD-WASHBURN STORELECTRO COMPANY.

ELECTRICIANS are showing great interest at the present time in the new storage battery just being placed on the market by the Ford-Washburn Storelectro Company, of Cleveland, Ohio. A representative of THE ELECTRICAL ENGINEER had the privilege, some days ago, of witnessing a number of tests to which one of these cells is habitually subjected. Perhaps the most interesting of these performances was the repeated short-circuiting of a cell without the least perceptible effect on it. Large heavy copper strips were run from a cell through an ammeter of practically no resistance and the whole charge of the cell discharged through it.

The ammeter showed between 350 and 400 amperes, keeping it right up until just before the cell was exhausted, when it slowly dropped to zero. The same process may be repeated as often as desired. The battery has no grids, cannot buckle, and according to the opinion of leading patent experts in this country is not an infringement upon the Brush patent. The company has been running a car fitted with its new battery for some months over the Woodland and West Side lines, also over the Euclid avenue and Central avenue lines with great success. The officers of the company are as follows: George A. Ford, president; J. F. Parkhurst, vice-president; W. H. Marshall, treasurer; Edward S. Ford, secretary. The company besides preparing to push its battery aggressively, will also continue the manufacture of dynamos, motors, etc. There seems to be no reason why the storage battery may not be guaranteed electrically for three years at least, and it only remains to see what mechanical modifications, if any, shall be indicated as the battery is adopted for different kinds of work.

HUYETT & SMITH MANUFACTURING CO.

THE HUYETT & SMITH MANUFACTURING CO., of Detroit, Mich., which has just brought out a combined exhaust fan and motor, in which the armature and fan are on the same shaft, is preparing for a lively summer. The company is now having great difficulty in keeping up with its orders for all sorts of exhaust fans, and owing to its compactness and great efficiency, the new combination fan bids fair to enjoy a brisk scale.

The Huyett & Smith Co. also are very successful with their system of heating, which has already been adopted by a number of electric light and power companies. The heat of exhaust steam is used and distributed by means of fans and large pipes; in summer the same plant can be used as a cooling device, the air being passed over coils of pipe through which ice water is running. The company frequently puts in a plant with a guarantee to keep the temperature of a building, say, at 70 degrees the year round, regardless of the conditions out of doors. As the new type of combined motor and fan can be used in summer, any building, such as a church or theatre, may be kept cool by simply taking current from the nearest mains, thereby avoiding the necessity of keeping up fires and steam. Theatre managers, especially our enterprising New York managers with summer attractions on their boards, would do well to look into this matter.

SOUTHERN NOTES.

THE CITY HILL, RICHMOND, VA.—We extract the following notice from the Baltimore *American*, of April 22d, regarding the conduit system of the Interior Conduit and Insulation Company, of New York: "The contract for the electric equipment and interior wiring of the new City Hall, at Richmond, Va, was awarded yesterday to the Southern Electric Company of this city. This is one of the largest contracts of the kind ever made. The company will use the Interior Conduit Company's system throughout, which comprises a method of insulating tubing, together with all the modern appliances for safety and convenience, giving full control of the electric plant at one central point in the building. The contract was awarded to the Baltimore house owing to the superiority of their work, although they were not the lowest bidders."

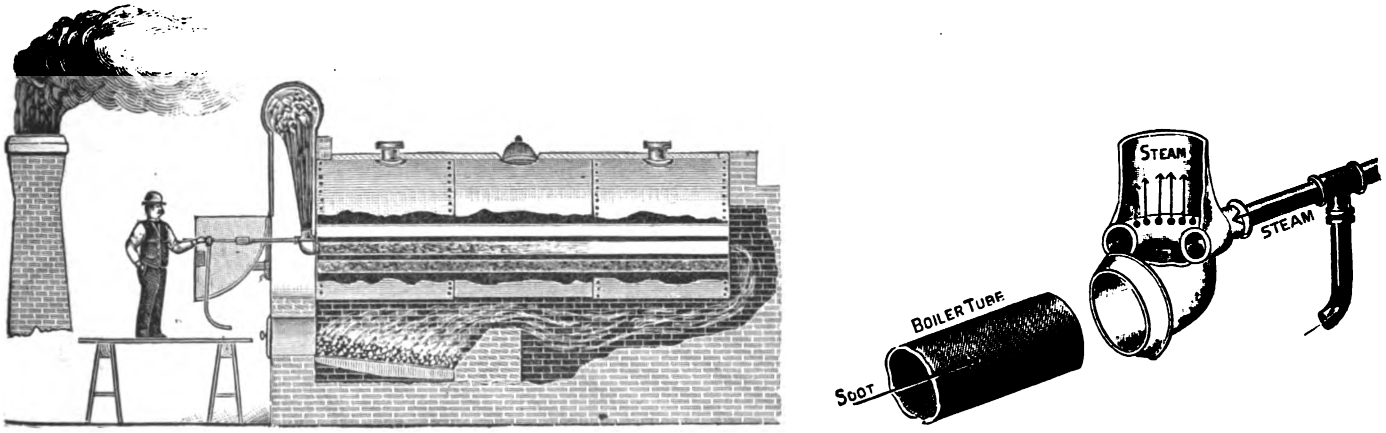
THE RIES ELECTRIC SPECIALTY COMPANY, of Baltimore, are meeting with remarkable success in the sale of their Ries regulating socket.

LOCKPORT GAS LIGHT CO., Lockport, N. Y., have added another 100 h. p. Ball engine, manufactured by the Ball Engine Co., Erie, Pa., to their present very complete electric light plant.

MESSRS. F. R. DRAVO & CO., Pittsburgh, representatives of the Ball Engine Co., Erie, Pa.. have made installations of Ball engines in the following office buildings in Pittsburgh: The Central District Telephone and Telegraph Building, the Vandergrift Building, and the Schmidt Building.

BALDWIN'S VACUUM BOILER TUBE CLEANER.

As long as the steam boiler continues to be the initial source of energy for electric light and power plants, any device for improving the condition of boilers, or preserving them in good working order, will be of interest to the electrical engineer. One of the greatest inconveniences in the use of boilers for any purpose is the perpetual tendency of the tubes to become filled with soot, which not only soon fills the entire tubes but gathers in large quantities at the back of the fire bridge wall and at the back end of the boiler. The heating surface of a boiler in this dirty condition is seriously impaired, and many devices are in use, more or less effective, for cleaning out the tubes and the chambers. We take occasion this week to show our readers the latest device in this line, Baldwin's vacuum boiler-tube cleaner, which possesses many entirely new and important features, and utilizes the vacuum principle, an entirely new adaptation in boiler-tube cleaners. Fig. 1 shows a section of a boiler, illustrating the method of applying the cleaner, with the soot and dust being *drawn out* of the tubes and forcibly *ejected up* the chimney. Fig. 2 shows the cleaner in section, from which the principle of its action will be readily understood. The heater is made of a brass composition, and is shaped like an elbow. It has a conical-shaped mouth for insertion in the tube. The steam is admitted into the back of the cleaner and passes into an annular chamber, surrounding the passage for the gases and soot, with small perforations on the upper side. When the steam is turned on it rushes upwards through these holes, and creates a vacuum, thereby drawing out all the accumulation of soot in the tube, *in the direction of the natural draft*, and sending it where it ought originally to have gone, that is, up the chimney. By this method no steam is admitted into the tube, and therefore *no scale* is formed, and the inside of the tubes is always kept dry. The steam being wire-drawn through the small apertures, is first superheated, and becomes thoroughly dry, so that it is impossible for the soot to stick in the chimney or passages. One of the greatest advantages of this method, is the fact that as the soot is drawn out in the direction of the draft, and not blown around the boiler-room or into the other tubes. This prevents in a large measure the disagreeable work of cleaning out the back connection. It is the opinion of many who have used this cleaner, that it is the best ever invented, as it works on the right principle, and is most practical and clean. It keeps the stack and combustion chamber clean, and will actually even draw out all the soot and dirt which accumulates back of the fire bridge wall. The Baldwin cleaner is manufactured by the Oliver P. Clay Company, of Cleveland, Ohio, and is the invention of Mr. F. Ruel Baldwin, M. E., of New York, who is also agent for New York State. Messrs. S. C. Nightingale and Childs, of Boston, are the agents for New England and are already introducing it into a large number of boiler-rooms in the East.



Figs. 1 and 2.—Baldwin's Vacuum Boiler Tube Cleaner.

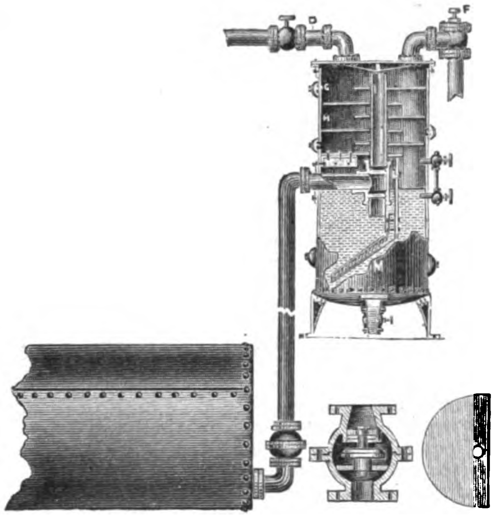
THE RAILWAY EQUIPMENT CO.

Mr. W. R. Mason has purchased in behalf of the above company, of which he is general manager, the capital stock, entire business, stock in trade, etc., of the Electric Merchandise Co. The consolidated business will be carried on under the name of the Railway Equipment Co., which has its headquarters in the Pullman Building, Chicago, where it will continue to build up its trade as only a first-class mason can.

The 150 h. p. engine furnished the Kittanning Electric Light, Heat & Power Co., Kittanning, Pa., was started some time ago by F. R. Dravo & Co., Pittsburgh, agents of the Ball Engine Co., Erie, Pa. The engine gives universal satisfaction.

THE BUFFALO FEED-WATER HEATER AND PURIFIER.

Every one connected with the management of steam boilers is familiar with the care and labor required to keep them clean and prevent the formation of scale or incrustation on the heating surfaces, and many devices for obviating this difficulty have been invented. One of these, the result of much careful study and experiment, is shown in the accompanying illustration. The inventor Mr. Robert Learmonth, of 200 Bouck avenue, Buffalo, N. Y., has become convinced that the method of precipitation is the most efficacious for the purpose and has devised his apparatus accordingly.



Buffalo Feed-Water Heater and Purifier.

The water, entering the purifier at the top, is heated by direct contact with the steam and falls from one to another of the spray plates to the settling chamber at the bottom, whence, after passing under the division plate, and up through the centre tube, it enters the boiler. Not only are all substances having a higher specific gravity than water prevented from passing into the boiler, but those substances having a lower specific gravity are also excluded by the equalizing tube in the centre, extending below the surface of the water and preventing all floating substances from entering the tube.

Unequal expansion is also prevented, as the water is heated to the required temperature before entering the boiler.

The purifier is simple, durable and effective. There are now twenty of them in use on steamers on the lakes, and twenty-five on stationary boilers on land, all of which have given entire satisfaction.

A SCIENTIFIC INVENTOR.

The *Industrial World* of Chicago remarks: "It is sometimes said that scientific men have never invented anything, but this is not true of Dr. Otto, who is known all over the civilized world as the inventor of the first economically and commercially successful gas engine."

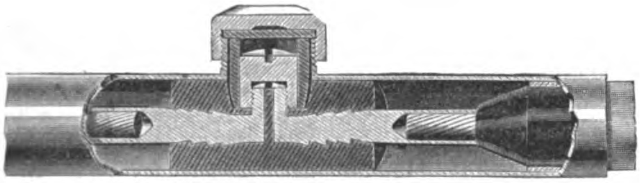
THE RAILWAY EQUIPMENT CO.

THE RAILWAY EQUIPMENT COMPANY having temporary offices at 617-619 Pullman Building, Chicago, is beginning business in a noticeably energetic manner. Already many large contracts have been filled from an improvised stock, while the number and importance of orders being received daily, show the confidence the trade has in the reliability of the new company. With the aggressiveness characteristic of the officers of the company, who are well known in the electrical business, having occupied similar positions with a former company, the new concern has purchased the Electric Merchandise Co. This will put it in position at once to fill all orders immediately, and do away with the difficulty of creating a new and complete stock. The many standard devices which hitherto have been handled by the Electric Merchandise Co. will be furnished by the new house, along with a number of new fixtures, which long experience in electric railway construction has developed. These facts place the Railway Equipment Co. in the first rank of electrical concerns at once, without the anxiety due to experiment making. Having purchased the only company with exclusive business in manufacturing and furnishing electric railway supplies, it now assumes the same position. It will give its whole attention to supplying the needs of electric railways of whatever system. That will be its exclusive business. It will advocate no particular system and believes in all alike. Mr. W. R. Mason's connection with the Railway Equipment Co. as general manager, will do much to recommend it to all railway companies, old and new.

CUTTER'S NEW CONDUIT CONNECTOR.

THE need of some means of disconnecting underground arc circuits in order to test them, has shown itself in the demand for the conduit connector put on the market a year ago by George Cutter, of Chicago. Since then, the experience with it has suggested a number of modifications which make the latest form both simplier and more serviceable.

The illustration shows this new pattern, which has metal terminals moulded in a block of hard rubber, connection being made or broken through a metal screw cap. The ends of the two cables are soldered into the split terminals, and the brass shell which is made to fit the lead covering on the cable is readily brazed into a solid mass with the lead. A suitable rubber insulation keeps the outer cap out of circuit and makes it air-tight. This form of connector is quickly put in place and allows the ends of the two sections to be disconnected in a very few minutes. George Cutter has made many hundreds of them for use in Chicago alone, where a year's experience has shown this conduit connector to be indispensable for the safety of the circuits.



CUTTER'S NEW CONDUIT CONNECTOR.

THE EDISON TELEPHONE AND TELEGRAPH CABLES.

As electrical knowledge becomes more widespread, and the manufacture of electrical apparatus rises towards perfection, customers become increasingly fastidious. Fully posted as to the new developments, and provided with the latest measuring devices, their demands call forth new efforts on the part of the manufacturers. This has been especially true of wires and cables. Considerable difficulty, for example, has been experienced in lowering the static capacity to the figure stipulated in the specifications of the telephone and other companies. A short time ago a figure of .20 or .21 microfarads was considered satisfactory, but this has been decreased year by year until now .080 microfarads is required.

Although the Edison General Electric Co. have for many years past been manufacturing telephone cable, they have only recently put in the immense lead presses which now enable them to turn out complete lead-covered cable. With these new facilities, their difficulties in the direction just mentioned have been overcome, and several cables lately shipped have shown a static capacity of not more than .075 microfarads. In striving to lower the static capacity, the matter of insulation has not been neglected, and a remarkably high insulation has been obtained in the case of every cable which has left their works.

The one feature, however, in which they may be considered to excel, is their lead cover. It has been customary, and indeed is still the general practice, to press the lead over the core in a semi-viscous state, the molten lead being poured into the press. Lead in this condition carries on its surface a thick scum consisting of various impurities, oxides, etc. This can be partially removed by a ladle, but it is impossible to remove it entirely, and even when pouring the lead into the press, considerable oxidation necessarily takes place, as lead oxidizes immediately on contact with the air, especially when in a molten condition.

Recognizing that such a cover could not be homogeneous and would be far more subject to attack by gases and acids than a pipe consisting of pure lead, the Edison Company determined to adopt the process of Siemens & Halske and their presses, and use absolutely cold lead. From the slugs of lead every particle of oxide is removed before insertion in the press, and as the pressure is increased the lead is pressed out over the cable, enclosing it in an armor impervious to air or water. Comparison between cables armored by the cold-press process and those covered by the hot-lead process has proved the superiority of the former. It is an undisputed fact that if two pipes filled with water be taken, one made by the hot process and the other by means of the cold press, and subjected to high atmospheric pressure, the fluid will ooze through the former while the outside of the latter will remain perfectly dry. This has been very prettily shown by coloring the water in the pipes with aniline, which could be plainly seen on the outside of the hot-pressed pipe after subjection to great pressure.

Cable recently supplied to the Metropolitan Telephone Company, of New York, has received unqualified approval, and although dry core was used, the cable could be handled as well as one made with the saturated core. The uniform gauge of the cable and its smoothness were also matters of appreciative comment. The Pacific Telephone & Telegraph Company, of San Francisco, recently placed a large order for this cable, the lead sheathing enclosing no less than 100 pairs of wires.

RAILWAY WORK IN DUBUQUE, IOWA.

MR. J. A. RHOMBERG has concluded arrangements for the remodeling of his electric street railway in Dubuque, Iowa. The Detroit Electrical Works furnish the equipments for 30 Standard motors, while the J. G. Brill Company are building six new motor cars, and the St. Louis Car Company have obtained the contract for ten trailers.

The overhead work comprising the setting of poles and wiring was let to the Edison Company, who will also furnish a generator. Some smaller contracts were made, the whole amounting to about $75,000.

Mr. Rhomberg intimates that from the many systems, he has selected the very best and proposes to have one of the best equipped lines in the country.

THE DONALDSON-MACRAE STORAGE BATTERY IN PHONOGRAPH WORK.

IN a recent issue one statement made it appear that a Donaldson-Macrae storage cell had run a phonograph for 100 consecutive hours. This should have read 160 hours, as attested by the following letter received by the company:

THE COLUMBIA PHONOGRAPH COMPANY.
BALTIMORE, September 4, 1891.

W. W. DONALDSON,
President. Donaldson-Macrae Electric Company, Baltimore, Md.

Dear Sir.—The Donaldson-Macrae electric storage battery delivered to us August 28, 1891, composed of seven plates, the weight of the elements being thirty three pounds, the total weight being fifty pounds, we started on the above date on a motor phonograph, in our office, and ran for one hundred and sixty (160) *consecutive* hours. This is the best record of any battery of the same weight which we have used.

From the few number of plates and the general construction of the battery and the capacity thereof, we do not hesitate to say that in our opinion this is the best storage battery which has yet been produced for phonograph work.

We beg to remain,
Yours truly,
(Signed) COLUMBIA PHONOGRAPH CO.,
Baltimore, Md.,
By N. R. BARNES, Manager.

ELECTRICAL ACTIVITY AT PEORIA, ILL.

THE First Baptist Church was formally dedicated last Sunday. It is furnished throughout with incandescent lamps, 175 being used in all. They are run on a 50 volt alternating circuit. Current is furnished by the Jenney Electric Light and Power Co.

H. R. WOODWARD, general manager of the Central Railroad Company, has resigned, and J. H. Findley will be his successor.

THE city council has granted a franchise for another electric railroad to operate in the territory between the two existing lines. It will probably be run in connection with the Central Railroad.

THE power house for the Ft. Clark electric line is finished, and the machinery is being put in position. The track and wire work are also nearing completion. They expect to be running by May 10.

THE CENTRAL RAILROAD COMPANY are laying a new track on the Main street hill, and are using 65 pound rails.

THE FORT CLARK RAILROAD have filed for record a mortgage on the road for the sum of $250,000. It was given to the Illinois Trust and Savings Bank of Chicago. This represents the electric equipment of the street car company in question.

OPENING OF THE YONKERS, N. Y., ELECTRIC RAILWAY.

The Yonkers Electric Railroad was opened for general traffic on Monday, May 2, and cars are now running regularly, giving general satisfaction by their smooth and noiseless riding. The outfit of the generating station is of the most improved type, containing two Edison 100-kilowatt dynamos, directly belted to high speed Ball & Wood engines. Gearless motors of the Eickemeyer-Field system are used, which drive both car axles by means of parallel rods from one 20 h. p. slow speed motor, thus avoiding all noise and wear and tear incident to high speed machinery.

This road is of special interest owing to the fact that the rails have not been relaid, but the old horse car rails, which had done service for many years, have been left undisturbed, and have only been bonded. This course has been pursued because in this type of gearless motor the whole motor weight rests upon the car springs, and hence the destructive blow exerted upon the rails by the momentum of the motor is entirely eliminated.

THE VARLEY ELECTRIC TIME CALL.

This call is designed as a labor-saving apparatus, and to make absolute calls and service in hotels, livery stables, and other places in which it is desired to give prompt attention and security to customers, and is of use also in hospitals, factories, offices, and in fact in any place where punctuality is necessary.

It is a common thing for a business man to put up at a hotel, for the express purpose of getting away on some important business engagement, instead of staying at home over night, leaving in the office of the hotel a "call" for the morning. The clerk enters the time in his book and the guest retires, believing he will be called in the morning at the proper hour; sometimes he is, but frequently he is not. With the time call, illustrated herewith, the forgetting of the time is almost impossible.

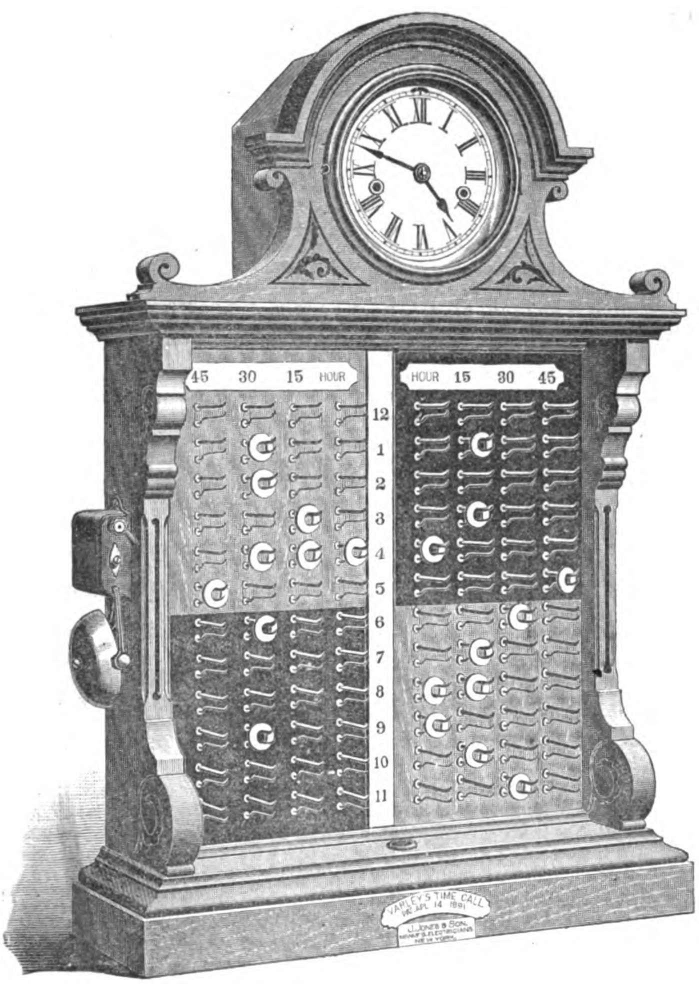
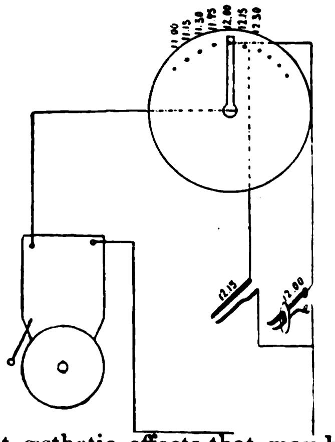
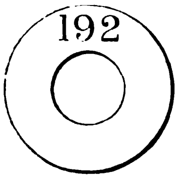


Fig. 1.—Varley Electric Time Call.

The general appearance of the call is shown in Fig. 1, while Fig. 2 shows the connections. Beneath the clock are the pins arranged in line with the hour, quarter, half and three-quarter hour lines. When a guest desires to be called at 5.45 a. m., the clerk takes a tag, Fig. 3, which is of metal, numbered in accordance with his room, from the keyboard, slips it over the two metal pins under the figure "45" and to the right of the figure "5," these two forming the hour for call. The placing of the tag in this way closes the circuit at that point, and only needs contact on the clock dial to complete the entire circuit. Nothing further is required until the clock reaches the time of 5.45, when the bell will ring, and





highest æsthetic effects that may be reached with correct taste and judgment.

II.

The house taken as the best illustration in New York of the furthest advance in modern electrical engineering practice as applied to residences is that of Edward H. Johnson, Esq., 36 West Fifty-sixth street. Like many others in the

continue to ring until the tag is removed. This tells at once the room to be called, and there is no possibility of mistake if there is any one about to hear the bell.

When ten guests are to be called at the same time, ten little room tags are placed on pins in the same manner as one. The dark portions of the board represent night, and the light portions day.

Other tags are manufactured with a metal interior ring capable of closing the circuit, while the rest of it is made of a composition on which memoranda may be made. This enables the clerk to tell whether room 192, for instance, wants cigars, ice-water, etc.

For convenience of having tags at same point at which the instrument is placed when so desired, a board is furnished with hooks numbered to correspond with the number of rooms.

The time call is handled by Messrs. J. Jones & Sons, 602 West 22d street, New York.

THE PURITY OIL FILTER.

The Purity Oil Filter Manufacturing Co., of 107 First avenue, Pittsburgh, have an excellent oil filter, the use of which would save a large proportion of the oil expense in central stations and power houses. It has already been tried in a great many places with unvarying success, and recommends itself by cheapness, simplicity and efficiency. Among the latest sales are those to the following concerns: New Castle, Pa., Wire Nail Co.; Pittsburgh Wire Co., Braddoock, Pa.; Pacific Rolling Mill Co., San Francisco, Cal.; California Elec. Co., San Francisco, Cal.; Golden Reward Mining Co., Deadwood, So. Dak.; Robt. H. Thorborn, Rapid City, So. Dak.; Pittsburgh Traction Co., Pittsburgh, Pa.; Henry Likly and Co., Rochester, N. Y.; Thomson-Houston Electric Co. for the Little Falls, N. Y., Electric Light Co.; Central District Telephone Co., Pittsburgh, Vandegrift Building, Pittsburgh, Pa.

ELECTRIC LAUNCH AT THE CRYSTAL PALACE EXHIBITION.

Messrs. Woodhouse & Rawson have lately added to their stand, at the Crystal Palace, an electric launch, and we doubt not the following particulars concerning the same will be of interest to our readers: The "Lily," as she is named, is 28 feet long, and has a beam of 5 feet 6 inches, a depth of 2 feet 10 inches, and a draft of two feet. The sides of the boat are carvel built of mahogany, with American elm keel and timbers, and she has an oak stem, stern post and dead-wood.

The electrical equipment consists of a 2 h. p "W. & R." motor, with current from 30 "Epstein" cells. Her weight, complete, is supplied 25 cwt. She will hold from 12 to 15 passengers, and with one charging, which occupies about four hours, will run at full speed (seven miles an hour) for five hours.

NEW YORK NOTES.

Messrs. P. Claus & Co. have opened offices at 52 Broad street, New York. They have made arrangements with a well-known company for the manufacture of their dynamos and motors, and in addition will do inspection and expert work, etc. They have sold a 3,300 incandescent light machine for use in Hammerstein's new Manhattan Opera House on 34th street, New York, and one of their 400-light machines will be installed in West 125th street in a new club and restuarant, while two 600-light dynamos go to Boston. A 1,000-ampere, 10-volt machine for electro-deposition goes to Philadelphia. The generator manufactured by Messrs. Claus & Co. is of the well known "Continental" type, and they are now prepared to undertake the installation of dynamos and motors for all classes of work.

Mr. Thomas S. Crane, patent expert and solicitor, formerly of Newark, N. J., has removed to New York, and is now established in room 282 Stewart Building, Broadway and Chambers street. Mr. Crane has followed his profession, with offices in Newark, for thirty-five years, where he has conducted a practice reaching over a wide territory and a large variety of inventions. Having for some years found it necessary to spend most of his time in New York, Mr. Crane has determined to make this city his headquarters henceforth. He has had a large and successful experience in electrical cases and in cases involving general physics, and will doubtless be generally welcomed to New York as an important addition to the ranks of patent solicitors and experts.

CUTTER'S NEW CONDUIT CONNECTOR.

The need of some means of disconnecting underground arc circuits in order to test them, has shown itself in the demand for the conduit connector put on the market a year ago by George Cutter, of Chicago. Since then, the experience with it has suggested a number of modifications which make the latest form both simplier and more serviceable.

The illustration shows this new pattern, which has metal

Berrang & Zacharias, the electrical contractors of 712 Cookman avenue, Asbury Park, N. J., are a most pushing and enterprising concern, and they have been doing a large amount of work in their vicinity. They carry a large supply of novelties and standard goods in their store. They have lately issued a very clever and pithy pamphlet, in which in the form of a conversation they advance a number of excellent arguments in favor of the various uses of electricity for light and power.

Mr Edward A. Maher, formerly mayor of Albany, and for some time the manager of the Albany Electric Illuminating Co., is coming to New York to take the presidency of the large "Huckleberry" system of trolley roads in the annexed district of New York city. It may not be generally known that Mr. Maher has once or twice been a favorite for the presidency of the National Electric Light Association.

The Sprague Electric Elevator Co. of 15 Wall street, have closed a contract with the Grand Hotel for one of their high speed passenger electric elevators, to take current from the local lighting mains. The company has been fortunate in securing the services as general agent of Mr. Charles A. Benton, late manager of the railway department of the Detroit Electrical Works. He is a host in himself.

W. R. Fleming & Co. have issued notice of their removal to the new Mail and Express Building, 203 Broadway, where they will enjoy larger quarters. They have been awarded the contract for four of their Ideal self-oiling automatic engines for the building and will thus be able to exhibit to their visitors, right on the premises, one of the finest examples of engine practice in the country.

The D. F. Frisbie Company, New York and New Haven, have secured desirable offices in the Mail and Express Building and are well nigh settled in their new quarters, where they will continue to handle their well-known specialties, including their combination of an elevator with C. & C. motor.

The U. S. Horse and Cattle Show Society has been giving a fine show during the week at the Manhattan Field, and the sports during the evening sessions were brilliantly lighted by the Mount Morris Electric Light Company under the direction of Superintendent C. G. Young.

The Fort Wayne Electric Company has removed from 115 Broadway to offices in the Edison Building, 42 and 44 Broad street, where, as before, they will be in charge of Mr. H. C. Adams.

Drake, Payson & Whittier, of Providence, R. I., have accepted the agency of the Security insulator for Rhode Island.

The Security Insulator Company have recently received some flattering testimonials from users of their insulators.

S. G. Booker, manager of the Fidelity Carbon Co., of St. Louis, spent several days in New York last week.

WESTERN NOTES.

The Electric Appliance Company are getting in shape for the summer trade on fan motors, and have secured the agency for the Meston alternating current fan motor, which, on account of its reputation as the first alternating fan motor on the market, is apparently going to have a very large sale the coming summer. The motor has been very much improved over last year's model. Some of its special features are regulation of speed at will, self-oiling bearings and carbon brushes which will last an entire season. No cost has been spared in the manufacture of the machine, and it is certainly a very handsome fan motor. The Electric Appliance Company are now exhibiting the first one of the 1892 pattern that has been received in Chicago, and it is exciting favorable comment from all who see it.

The M. C. Bullock Mfg. Co. have opened a hadsome new store, corner of Canal and Washington streets, Mr. A. B. Coulton, manager, where they carry a sample line of their well-known specialties, including Bullock-Corliss engines, Lane's band friction hoists, diamond-pointed core drills, wire rope haulage, rock drills and air compressors, Champion ventilators and a general line of mining machinery. They have also become the Chicago agents for the well-known Mundy hoists for contractors, quarrying, pile driving, etc.

The Electrical Supply Co. are filling their usual large orders in their three specialties, namely, "Shield" brand, Stanley transformers and Sunbeam incandescent lamp.

Mr. James G. Biddle, representing Queen & Co., Philadelphia, was a caller at the Western office of The Electrical Engineer last week.

PHILADELPHIA NOTES.

Mr. Wm. Hazelton, 3d, for a year or more in charge of the Philadelphia office of the Short Electric Railway Company, has been called to the home office in Cleveland, Ohio, to take the position of assistant general manager. Mr. Hazelton's well-known energy and business ability will, by this change, be used in a larger and more important field, and the representatives of other electrical companies who have had reason to fear him in competition with street railway men, cannot congratulate themselves that he is now out of their way, as his supervision of an important Eastern territory heretofore under his control will be as unremitting as ever. Mr. Hazelton is to be congratulated on his advance to a more important position.

Mr. J. Paul Gaylord, formerly with the Electro-Dynamic Company, was elected president and general manager of the Pennsylvania Electric Engineering Co. last week, while Mr. Lewis R. Schultz has been retained as secretary and treasurer. Mr. Gaylord has made a host of friends in Philadelphia and vicinity while with his former company, all of whom he would be pleased to meet at the quarters in the Penn Mutual Building. The Pennsylvania Company under its new management will continue as agent for the National alternating system apparatus, and will push their specialties, the Pennsylvania lamp, socket, switch and tape, besides keeping a stock of general electrical supplies on hand.

Mr. G. A. Wilbur, Philadelphia agent for the Fort Wayne Electric Co., reports the following sales since April 1st: Three 60 Wood arc light machines, Reading Light & Power Co.; one 60 Wood arc light machines, Shamokin (Pa.) Street Railway Co.; one 60 Wood arc light plant, Hamburg (Pa.) Electric Light & Power Co.; and four additional 60 Wood arc light machines and 240 lamps to the Southern Electric Light & Power Co. of this city, which gives the Southern Company a capacity of 600 arc lights of the Wood system.

The Supply Manufacturing Co., of 100 Wood street, Pittsburgh, Pa., is probably the largest company in this country make a specialty of commutators. This company has increased its plant until it now occupies the entire building of four stories at the corner of Wood street and First avenue, and is well equipped for the manufacture of railway and electric light supplies.

Pepper & Register have greatly increased their manufacturing facilities by leasing the entire building of four floors located at 117 to 121 North Front street, Camden, N. J. This firm is about to bring out some new apparatus which will be especially interesting to street railway people.

The Heisler Electric Co. will soon be out with an entirely new outfit of apparatus that will cover the general field of electric lighting and are now prepared to furnish estimates for the installation of complete storage battery plants.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

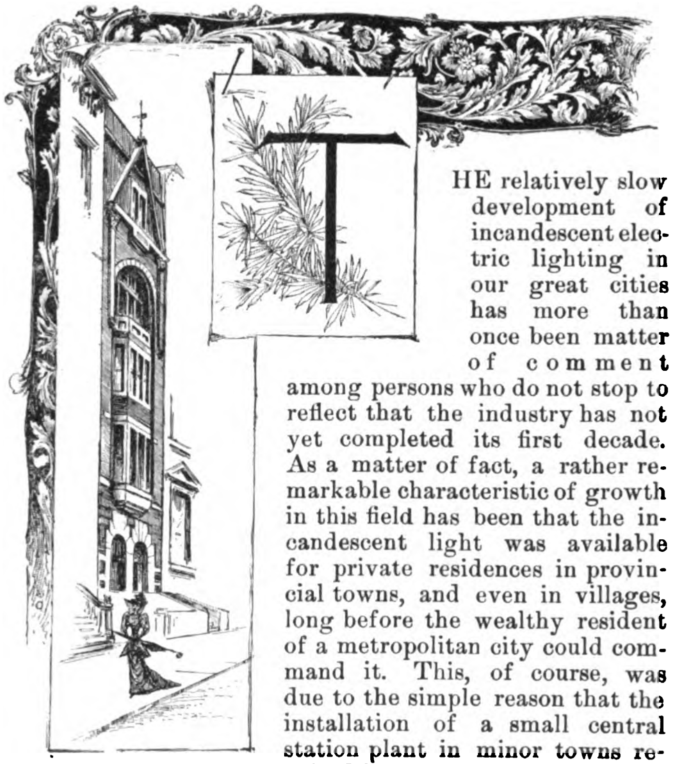
VOL. XIII. MAY 25, 1892. No. 212.

ELECTRICITY IN A MODERN NEW YORK HOUSE.

BY

T. C. Martin

I.



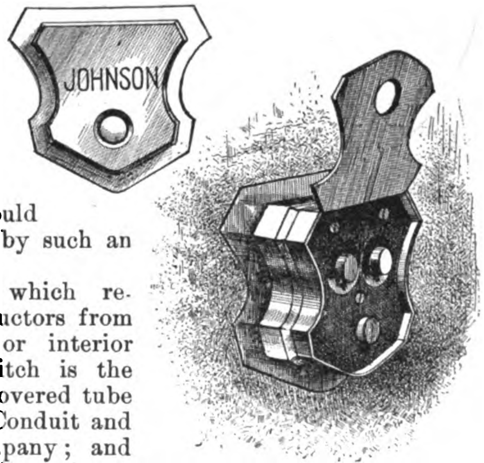
THE relatively slow development of incandescent electric lighting in our great cities has more than once been matter of comment among persons who do not stop to reflect that the industry has not yet completed its first decade. As a matter of fact, a rather remarkable characteristic of growth in this field has been that the incandescent light was available for private residences in provincial towns, and even in villages, long before the wealthy resident of a metropolitan city could command it. This, of course, was due to the simple reason that the installation of a small central station plant in minor towns required but a moderate investment and that the enterprise was often promoted by a single, public-spirited wealthy citizen; whereas in the larger communities the investment needed was considerable and the obtaining of a franchise was quite difficult. Hence the establishment of large electric light central stations was retarded until the commercial success of the new illuminant was proved by the operation of the more modest stations. Even then the installation of the larger central stations took place primarily in the business sections of the various leading cities, and long before their circuits had reached the residential neighborhoods, many of the ultra-wealthy and luxurious had put in isolated plants rather than endure any longer the disadvantages of gas.

This stage in the history of incandescent lighting has now been passed, for we find many of the newer central stations installed in districts where the patronage of private houses must constitute a large part of their income. The result is that a great many residences, especially those in course of construction, are being equipped with the electric light, and more than ever is seen the desire to break away from the stiff and conventional ideas embodied in the traditions and practice of what we may call the gas era, and to rescue decorations, pictures and tapestries from the quick detriment and ruin due to the conditions created by gas in process of consumption. Moreover there has sprung up a wish everywhere to enjoy the benefits of electric power for ventilation, pumping water, domestic elevators and the like, until at last the electrical engineer sees before him a range of work that is still very unfamiliar and that involves not a few problems. It has therefore seemed opportune to the writer to present a concrete example of what can be done in this direction, not only by availing one's self of all the later material improvements but by studying the highest æsthetic effects that may be reached with correct taste and judgment.

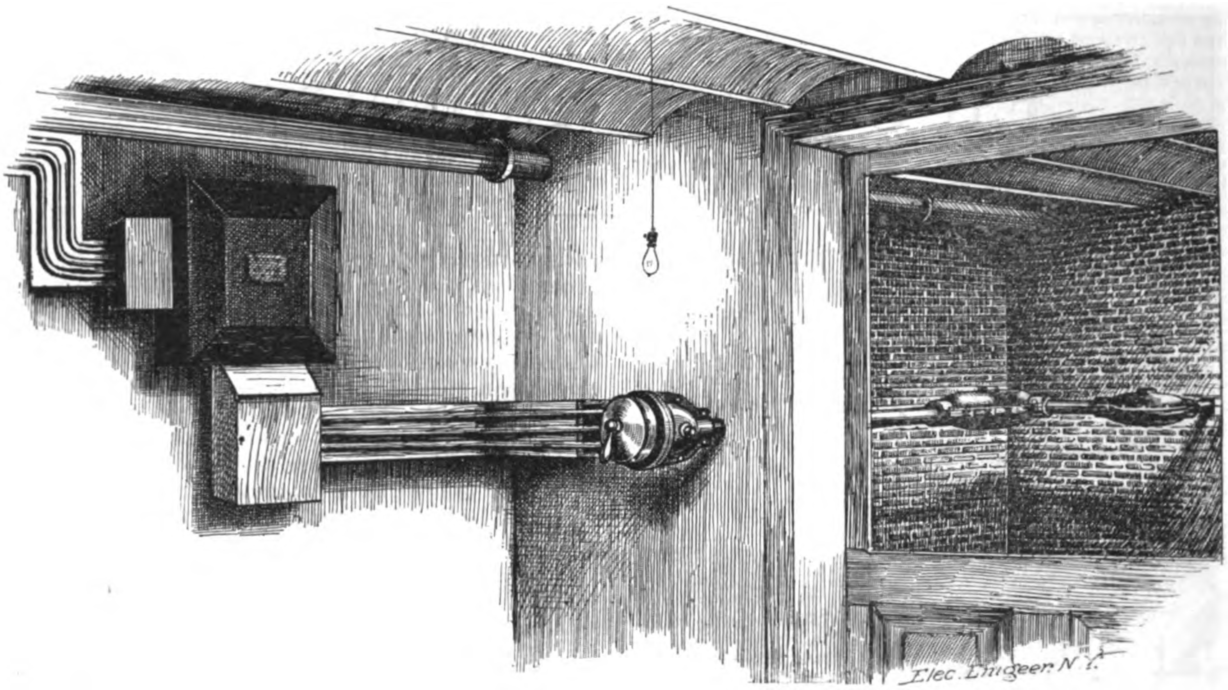
II.

The house taken as the best illustration in New York of the furthest advance in modern electrical engineering practice as applied to residences is that of Edward H. Johnson, Esq., 36 West Fifty-sixth street. Like many others in the vicinity, it derives current from the Edison mains, but there the similarity ends. As will be observed from the engraving on page 522, the street service from the standard underground Edison tubing for the three-wire system enters a vault in the basement, through the side wall, into the cellar. As the conductors come in they are first passed through a switch coupling and then to an Edison meter, which records the consumption of current for any and all purposes, hereafter described. The novel feature to be noted at this point is the switch which connects and disconnects the house and street services. It does its work without exposing any part of the conductors, the entire device being hermetically sealed; so that water might flow over it or be played against it without any effect whatever. At the same time, the entire house service can be instantaneously cut free at this point from the exterior mains, should any occasion arise. The value of such a device is apparent, and it is only natural to suppose that every house service would be safeguarded by such an arrangement.

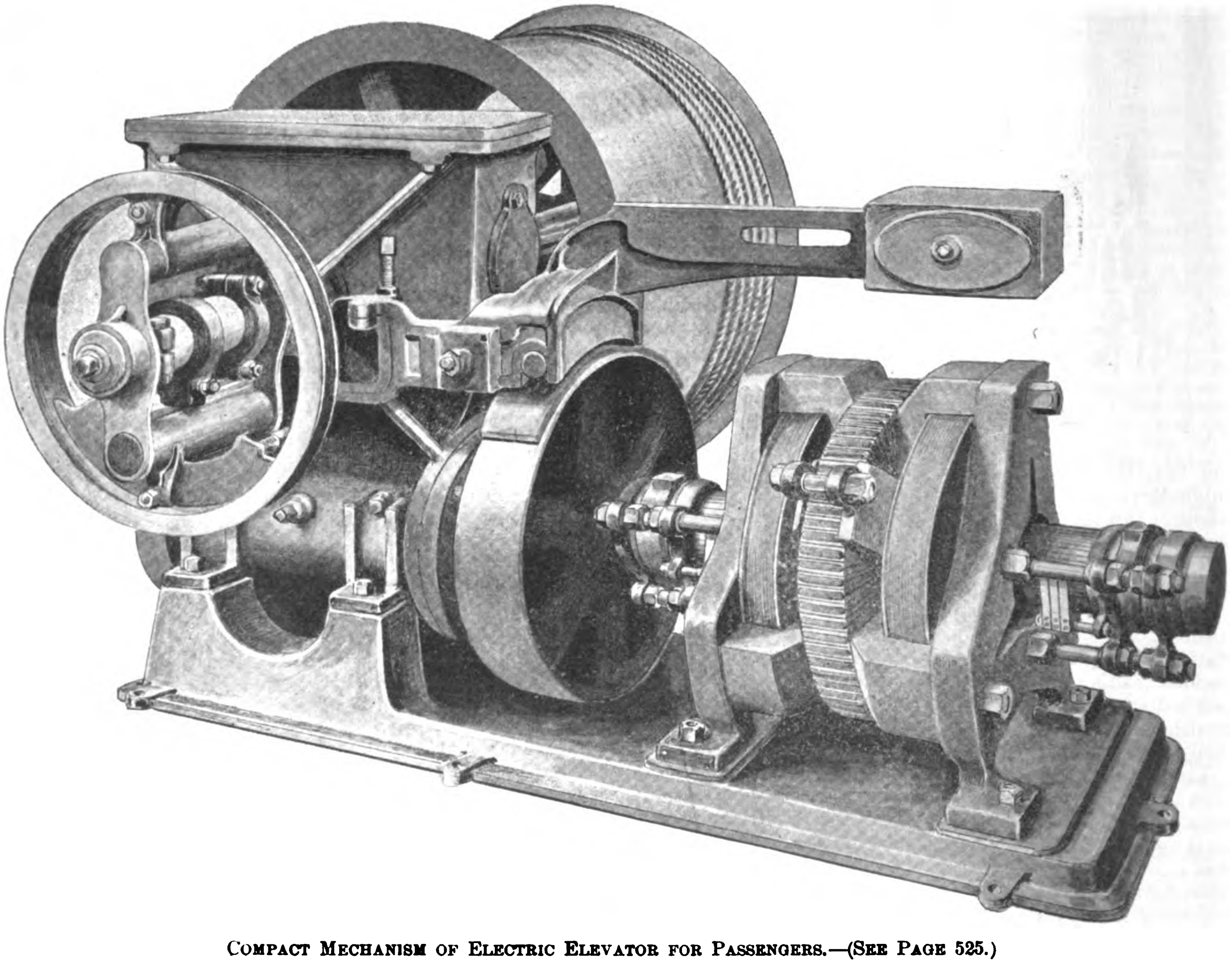
The tubing which receives the conductors from the house end or interior side of the switch is the standard brass-covered tube of the Interior Conduit and Insulation Company; and the same tubing is employed throughout the entire house in such a comprehensive way as to render it unquestionably the finest example of electric wiring extant. It is, in fact, largely because it exemplifies so well the modern approved methods of wiring that the writer has chosen this house for special description.



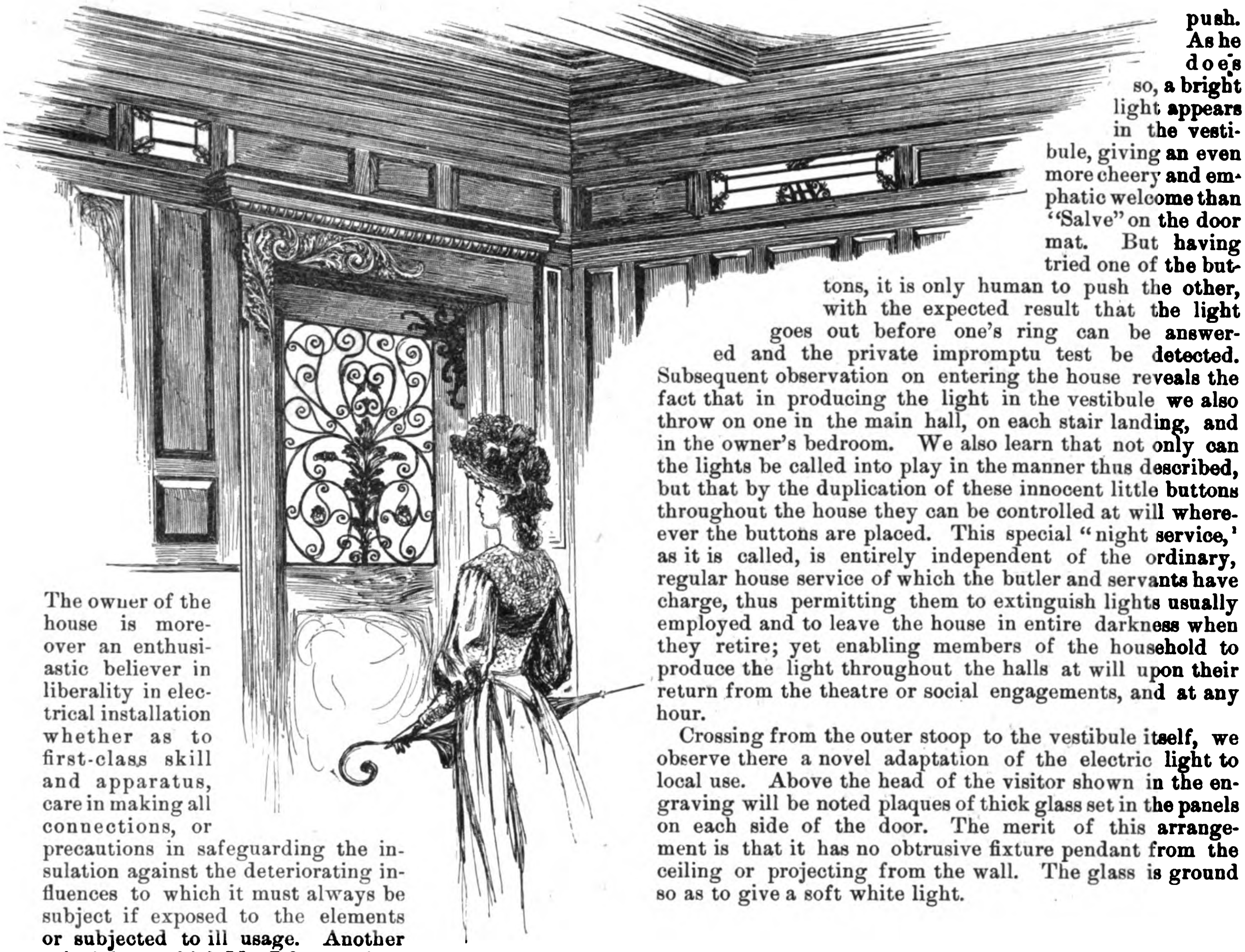
Front Door Bell, with Push Buttons Controlling Hall Lights.


Elec. Engineer N.Y.

Entrance of Service from Street, Passing Through Absolute Cut-Off Switch and Standard Meter.



Compact Mechanism of Electric Elevator for Passengers.—(See Page 525.)



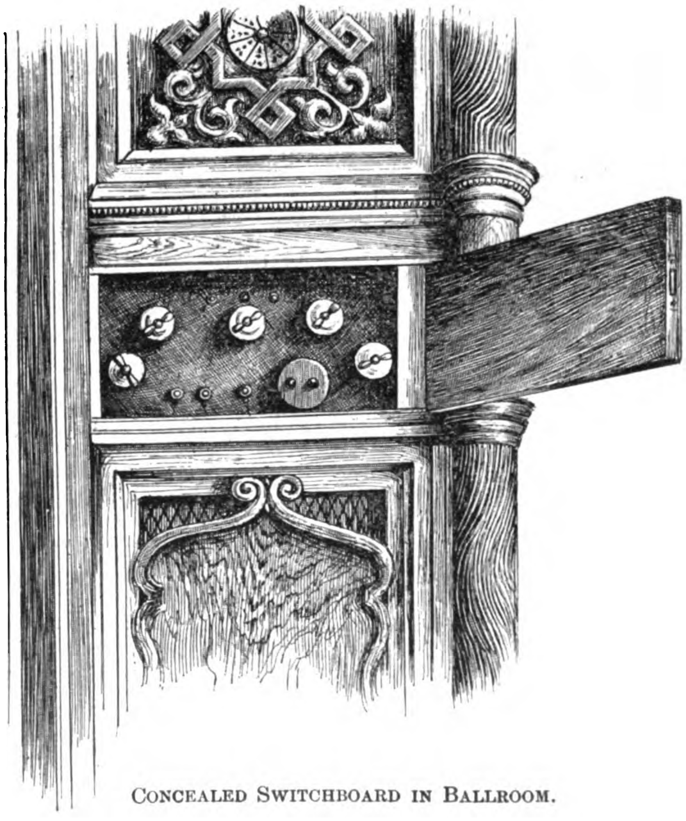
In the Vestibule.

The owner of the house is moreover an enthusiastic believer in liberality in electrical installation whether as to first-class skill and apparatus, care in making all connections, or precautions in safeguarding the insulation against the deteriorating influences to which it must always be subject if exposed to the elements or subjected to ill usage. Another principle to which Mr. Johnson gives his full support is that of extensive subdivision of the circuits, so that interference with one branch or run can at most deprive him of but a very small portion of the light normally employed in any room. It will therefore be observed here, and still more from the engraving shown later of the main switchboard upstairs, that there is apparently excessive multiplication of circuits and their enclosing tubes. But Mr. Johnson informs the writer that the extreme degree of convenience already enjoyed from having ready access to the terminals of such a perfectly subdivided and reticulated system of wires, thereby enabling him to couple any given lights in any such series as the special or momentary service of the house may determine to be most useful, has many times repaid the cost.

III.

Having for professional purposes entered the basement with the wires, we may now retrace our steps and make our approach to the main entrance as a guest, in a more conventional manner. The house was designed by Mr. Bruce Price, and those who are architecturally disposed may find more about it in the monograph on "American Architecture" by Mr. Montgomery Schuyler, recently published by the Harpers. As the eye ranges over its fair proportions, one's attention is caught by the name plate at the side of the doorway. Perhaps most visitors would not notice anything extraordinary about it, but an electrician as he pushes the button finds that the face of the plate is hinged at the top. He lifts it and two other buttons are disclosed. One of these his curiosity may prompt him to push. As he does so, a bright light appears in the vestibule, giving an even more cheery and emphatic welcome than "Salve" on the door mat. But having tried one of the buttons, it is only human to push the other, with the expected result that the light goes out before one's ring can be answered and the private impromptu test be detected. Subsequent observation on entering the house reveals the fact that in producing the light in the vestibule we also throw on one in the main hall, on each stair landing, and in the owner's bedroom. We also learn that not only can the lights be called into play in the manner thus described, but that by the duplication of these innocent little buttons throughout the house they can be controlled at will wherever the buttons are placed. This special "night service,' as it is called, is entirely independent of the ordinary, regular house service of which the butler and servants have charge, thus permitting them to extinguish lights usually employed and to leave the house in entire darkness when they retire; yet enabling members of the household to produce the light throughout the halls at will upon their return from the theatre or social engagements, and at any hour.

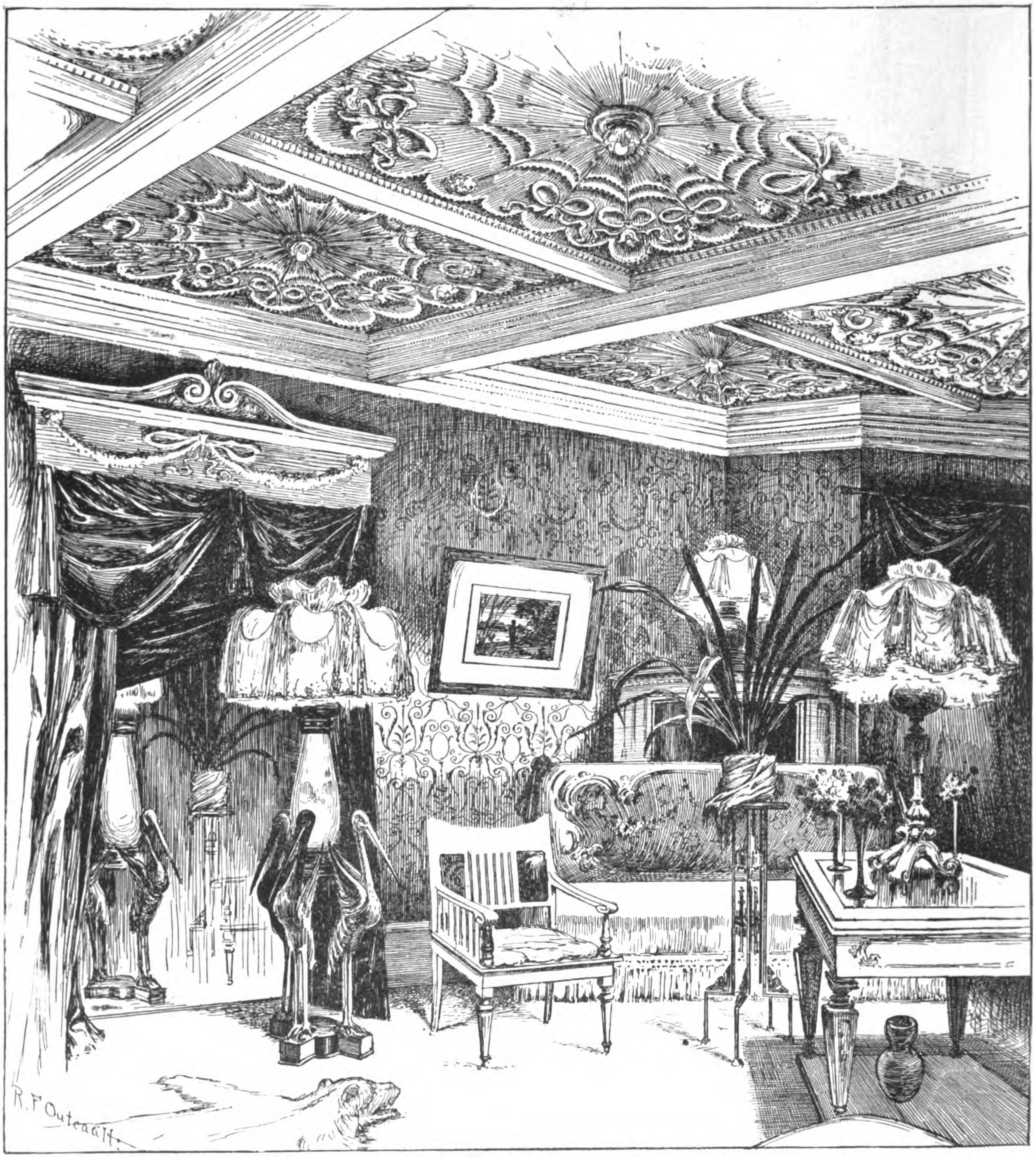
Crossing from the outer stoop to the vestibule itself, we observe there a novel adaptation of the electric light to local use. Above the head of the visitor shown in the engraving will be noted plaques of thick glass set in the panels on each side of the door. The merit of this arrangement is that it has no obtrusive fixture pendant from the ceiling or projecting from the wall. The glass is ground so as to give a soft white light.



CONCEALED SWITCHBOARD IN BALLROOM.

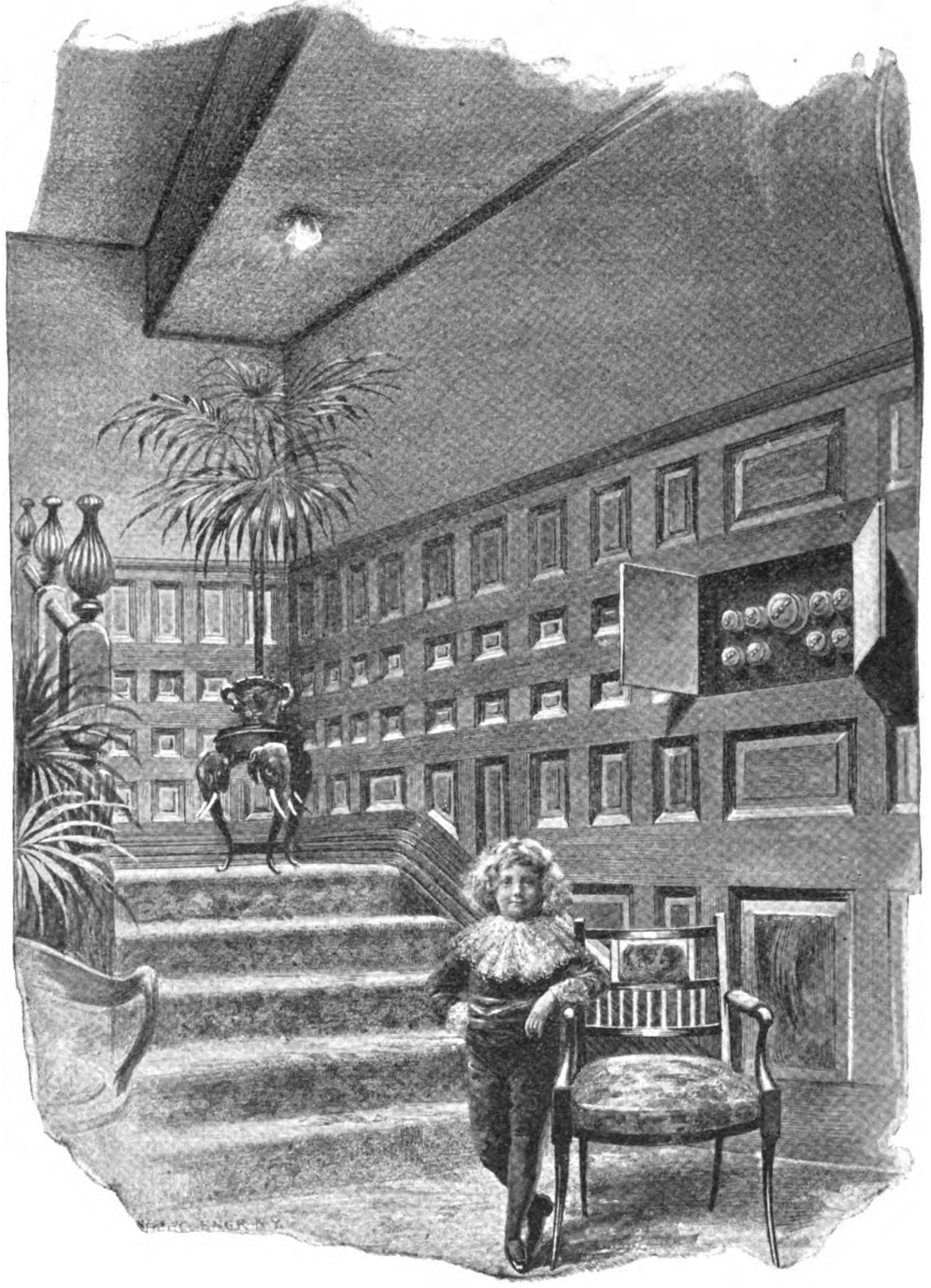
IV.

As we pass in through the front door, we find ourselves in a large hall and facing the first flight of a broad stairway set with palms. Through the portieres on the left and beyond a carven screen, we pass with our host into the ballroom, occupying a large part of the ground floor. The lighting in this chamber is perhaps the nearest approach to the conventional of any in the whole house. The decorations are in the Moorish style and the brackets, swinging lamps, lanterns, etc., are in perfect harmony. Some of the lights are set within panels in the ceiling. One or two of the fixtures are shown in the group sketch on page 526. A separate illustration is also given on page 523 of the ballroom switchboard, containing the switches, cut-outs, etc., for this room and for a very pretty, hidden music alcove. The pocket is within the woodwork of a column and is practically invisible when the door of it is closed. This method of switch concealment prevails throughout the house, and adds greatly to the charm of the electrical equipment, as does all mechanism which serves its end perfectly but is out of sight.


R. F. Outcault.

Drawing-Room Without Electric Fixtures: Lighted from Ceiling Panels and by Movable Lamps.—(See Page 526).

The lighting in this chamber is enhanced in beauty by one or two special pieces, of which the most striking is furnished by a handsome painting on porcelain of "Electricity." A female figure in the centre holds aloft the incandescent light, while two cupids carry on a long-distance telephone talk from clouds on each side of her. This appropriate picture—a souvenir of the Paris Exposition—is set in a deep box enclosed within which are a number of small incandescents, which when switched on not only bring out the subject admirably but shed a mellow light over the surroundings. Mr. Johnson thinks that a day may come when many rooms will be lighted by their pictures.



CORNER OF STAIRWAY SHOWING PANELED SWITCHBOARD.

V.

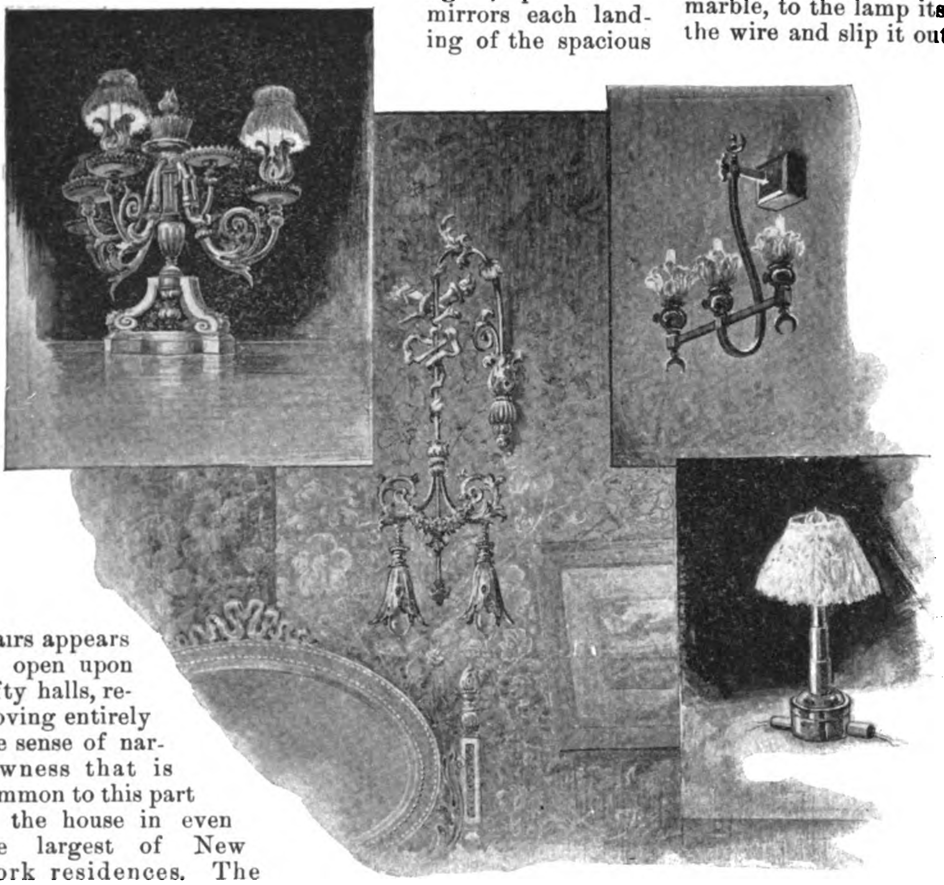
Beyond the ballroom, at the rear of the house, lies the billiard-room, where the lighting, as shown on page 526, is at the extreme of simplicity and yet warrants description. Four pieces of the brass-covered Interior Conduit tubing on the ceiling emerge radially from a central junction box, also metal-covered, and at the bent outer end of each run of tubing is a flexible cord holding a lamp with plain porcelain shade. This arrangement is not only as unpretentious as it could well be, but gives the best possible diffusion of light upon the green baize, at the same time keeping the lights well above the heads of the players as they pass around the table with their cues. It is also in such a place as this that the superior value of the electric light tells, for one thus escapes not only the cross shadows of lights on the wall, but the fierce heat that beats down from the ordinary gas or oil burners.

VI.

Through the billiard-room we can find our way to the offices that connect with the elevator and pump-room, adjoining the cellar of which a glimpse was had already. The electric pump—here of the Crocker-Wheeler make—is now a familiar object in many establishments, and does not require particular mention, though one can but admire again the pluck with which it grapples with its daily Sisyphean task and tries also to drain the Croton reservoir dry, with ceaseless throb and beat. But it is still unfortunately a rare thing to find a house that can boast of an electric elevator. Stairs that must be climbed, willy nilly, are a relic of barbarism, and now that electric power is as freely on tap as water, it is to be hoped that the day has arrived when the confirmed invalid, the delicate woman, or the feeble child, will be spared the exercise that belongs to the punishment of a convict. Here, at least, we find a passenger elevator, as shown in the illustration, novel in design both as to the motor and as to the manner of its application. The motor and gear are so placed upon an ordinary elevator as to replace the wonted pulley employed generally in connection with a steam engine. The characteristics of the motor permit of its being employed as a direct driver on the elevator drum without subjecting it or the elevator to any abnormal strain, no matter whether the speed of the elevator car be fast or slow. The compactness of the apparatus is also noteworthy in view of the restricted space that can be given up in most city houses to mechanism of this kind. Without going into further technical details, it may be pointed out that there is opened up in this direction an immense field of usefulness for electricity, one in which that servitor may be as great a boon as in lighting. Besides the direct benefit, many indirect ones are discernible. For instance, in the present case, the kitchen is at the top of the house, receiving all its supplies by means of the elevator. Not a few fine houses are spoiled by the manner in which the odors of the kitchen beset them, but with such an arrangement, now happily much more common than it was, it is possible to free one's residence from the slightest reminder of the cuisine. To this end, the electric elevator is a great help and incentive.

VII.

We may proceed now to the first floor, noting merely on our way the skilful manner in which by the combination of lights, plants and mirrors each landing of the spacious stairs appears to open upon lofty halls, removing entirely the sense of narrowness that is common to this part of the house in even the largest of New York residences. The point at which we have arrived, namely, the drawing-room, which stretches across the entire width of the building and overlooks the street from large bay windows, reveals conspicuously an emancipation from all the old ideas prevalent as to methods of lighting, and a very successful experiment in the treatment of light itself as something fluent and plastic, capable of being distributed like color for obtaining soft and harmonious effects. Perfect distribution of light is not an easy thing, and it may be questioned whether under the regime of cumbersome electroliers and massive fixtures it could ever be attained. Many salons that one goes into are brilliantly lighted, but after the eye has been hit half a dozen times with the full glare of clusters of lamps or has been worried by their reflections, the desire for outer darkness becomes rather fervent.

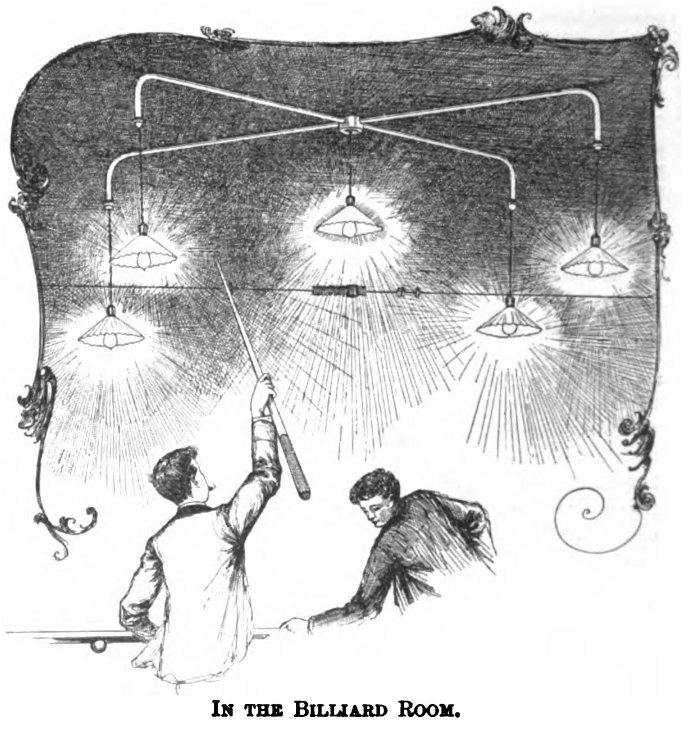


Group of Typical Fixtures from Ball-Room, Dining-Room and Bed-Rooms.

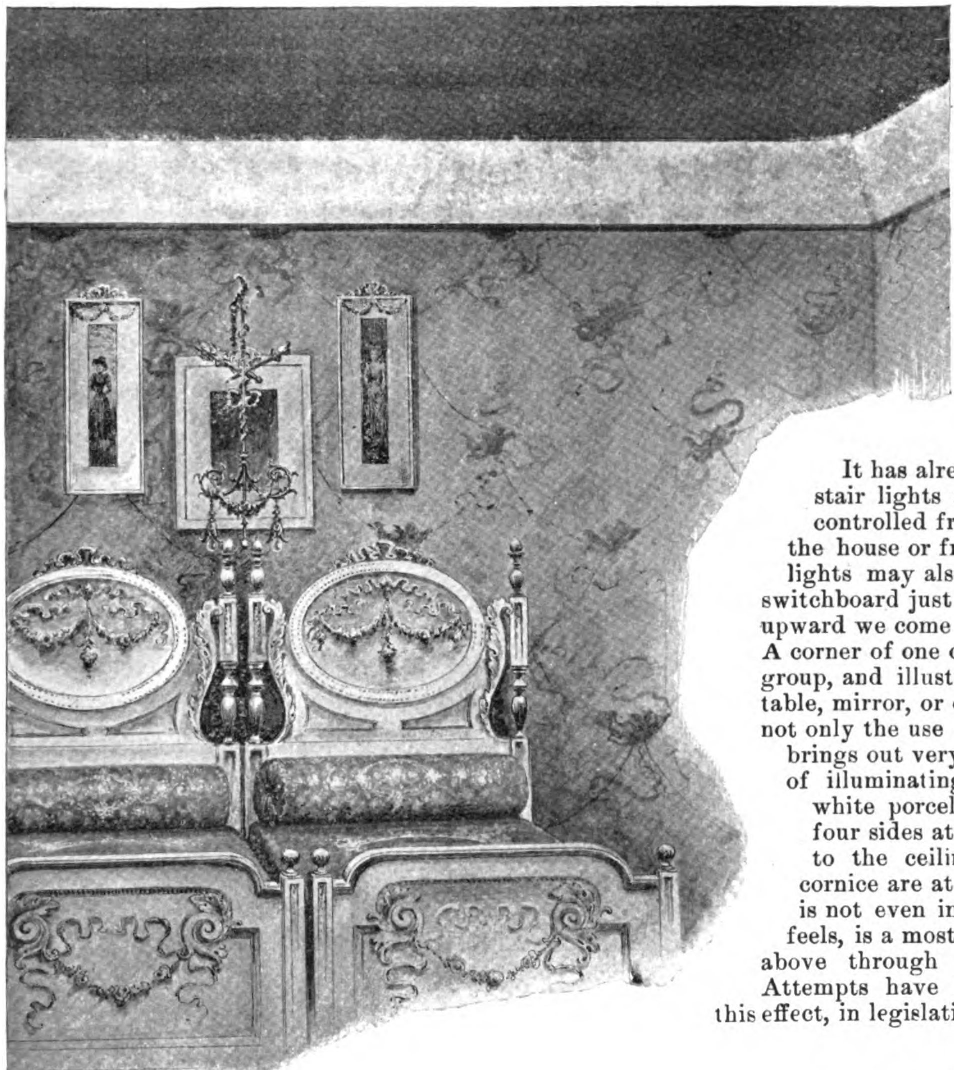
In this drawing-room, of which a picture is given on page 525, there is not a single bracket or fixture of any kind, and yet the fact of its being thoroughly lighted is accepted with as little thought as one greets midday sunshine. The decorations are in white and gold, and the frosted lamps set in the ceiling panels, in delicate tulip cups, do not strike the eye individually. We have not lights, but light. In addition, each of the ornamental lamps disposed casually about the room carries not only a light under its canopy but one within the body of the hand-painted vase. Hence the whole lamp is luminous, but with a charmingly diffused and pervasive effect, especially when enhanced by mirrors. Curiosity is naturally aroused as to the way in which the stork lamp, for example, or that on one of the onyx tables is reached by the circuit. The explanation is simple. It will be remembered that every wire—every inch of it—is within the safe enclosure of an insulated tube. Hence it may be drawn in or replaced at will without the disturbance of a single thing on the floors, walls or anywhere else. The wire comes up under the table, for instance, either at the side or through a central leg, and then is carried through an almost imperceptible hole in the onyx, or wood, or marble, to the lamp itself. Nothing is easier than to release the wire and slip it out, and then furniture can be moved, carpets be taken up, and any other process in the domestic economy can be gone through without the slightest fuss or inconvenience.

VIII.

The lights in the drawing-room are controlled from the large switchboard shown in the sketch of the stairway, and illustrated more in detail in a separate cut. As will be seen, the situation is eminently accessible, and yet when the door is closed, the mahogany paneling appears to be intact. This board controls also the lights in the library that adjoins the drawing-room, where the same methods are practically followed. When open, the board is an ornamental and highly finished piece of work, with polished slate base and all the details in brass. The Johnson vicelock switches are used, giving instantaneous and emphatic manipulation of the circuits; and the tubes with the wires are all brought to the face of the board. In other words, it is as though the back of the board had been made the front, rendering inspection a ready and simple thing at any moment. The board is remarkable in the range of control it allows of a large subdivision of circuits, all of which may be grouped and governed from it as though they were going through a series of intricate evolutions; and yet the board is barely a



In the Billiard Room.



A Bed-room Lighted by a Decorated Porcelain Cornice.

couple of feet square and would usually serve for only half a dozen lights.

This stairway opens, as already stated, upon the library, one of the most charming features of which is shown in our sketch of the "Business Nook." There is a good time coming when all of us will be able to put the telephone into our homes, and thus at any moment be in the world though not of it; and when that time arrives we shall do well to follow the example here set us. The wall bookcase alongside the cosy fire opens up at a touch and shows an attractive desk, where stands a long-distance telephone, district messenger box, and any other appliance that like the lamp of the Arabian youth will bring the tidings or service we call for. Our business with the public attended to, the case closes up noiselessly, and the world is once more barred out and cut off.

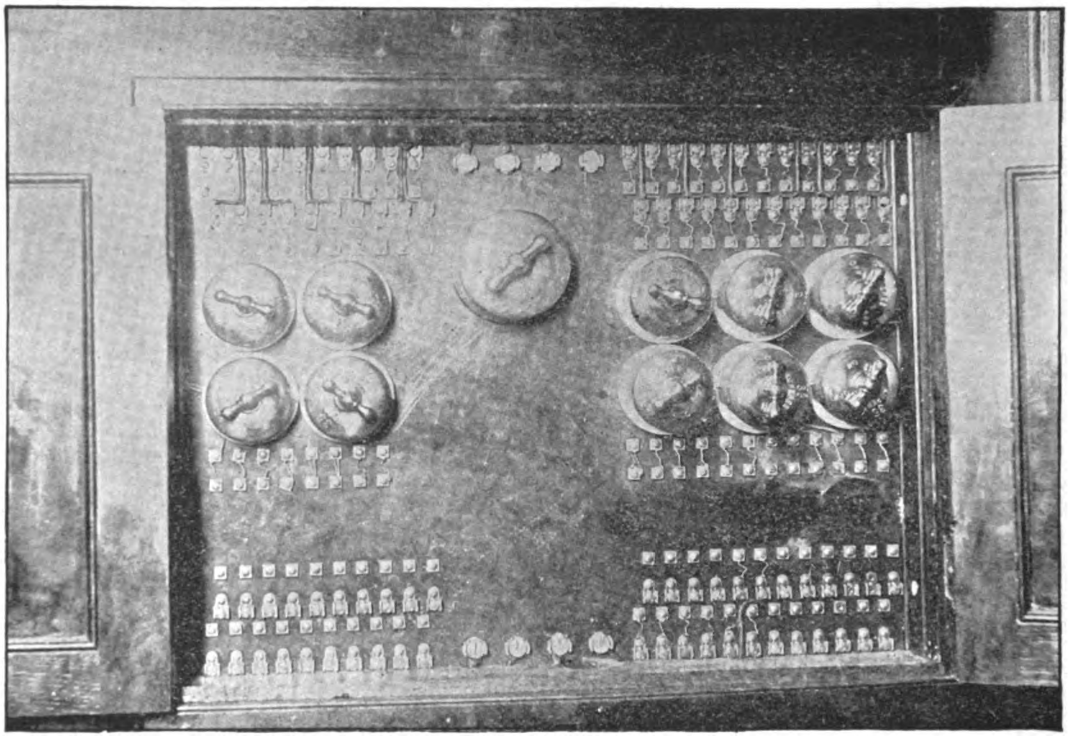
Immediately adjoining the library, is the large dining-room at the rear. Here the lighting is done by ceiling and side lights, but the circuits and tubing have been so arranged that the table may be specially lighted at any time with added and novel effects. An instance of this flexibility was afforded recently by a luncheon party given by Miss Johnson on the occasion of her graduation, when a large number of her companions in the graduating class gathered around tables arranged in a long double curve. The wires were led up to a number of special little frosted lights mounted on stands made very ingeniously out of sections of Interior brass tubing; and one of these stood by each cover. At the end of the luncheon the circuits were cut and each guest carried off her lamp as a souvenir. This little device is shown to the right in our group of pictures on page 526. The novelty of this style of "favor" has many points of recommendation, and if only for the welfare of the lamp industry the writer would be glad to see the practice extended, so that no young lady would go to a "pink lunch" or dance the German without expecting to carry home with her as a trophy one of the "bright lamps that shone o'er fair women and brave men."

IX.

It has already been explained that the hall and stair lights are on a separate circuit that may be controlled from the name plate at the entrance to the house or from the owner's bedroom; and these lights may also be thrown on or off from the main switchboard just shown on the stairs, following which upward we come to the bedrooms on the second floor. A corner of one of these rooms is shown in the fixture group, and illustrates the arrangement at a dressing table, mirror, or cheval glass. The other sketch shows not only the use of lights at the head of the bed but brings out very clearly the original method adopted of illuminating the room as a whole by means of a white porcelain cornice, which runs around the four sides at a slight angle inward from the wall to the ceiling. The lamps placed behind this cornice are at regular intervals, but their position is not even indicated. All that one sees, or rather feels, is a most delightful diffusion of the light from above through this delicately decorated porcelain. Attempts have been made on a large scale to obtain this effect, in legislative halls and other places of assembly,

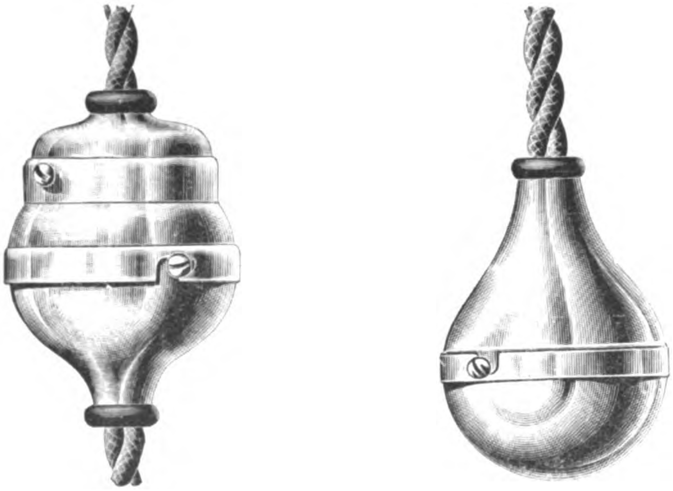
The "Business Nook" in the Library.

where the light is shed through a semi-transparent ceiling, but the result is harsh and crude to a degree as compared with what is seen here. These pictorial panels of porcelain give an ideally lighted bedroom, having seen which it is impossible to believe that an equal result can be attained in any other way. At the same time, the pendants controlling the wall lights above each bed enable one to read through the wee sma' hours, and extinguish the light at will, without moving and without fear of dropping off to sleep with the attendant risk of fire, as would be the case with gas or oil.



Details of Main Switchboard, on the Stairway.

While on this floor it is worth while to note that every bath-room and clothes closet has its pendant light, with a clever little "pull" switch, throwing the light on or off by the merest motion of the wrist. Mr. Johnson has also arranged some of these closets so that the opening of the door switches on the lights while closing it turns them off. The idea is an excellent one deserving of further application. The little switch here shown is also used as a pendant from the centre of electroliers, dispensing with key sockets and affording the readiest means for controlling the current on a single light or on a group. In one or two instances, Mr. Johnson has it arranged as shown in the other engraving, midway in the flexible cord of a pendant. This is done by simply cutting the cord and attaching the terminals to the binding screws provided for the purpose. With this again, the lights are turned on and off by a slight pull.



"Pull" Switches for Flexible Cord Pendants.

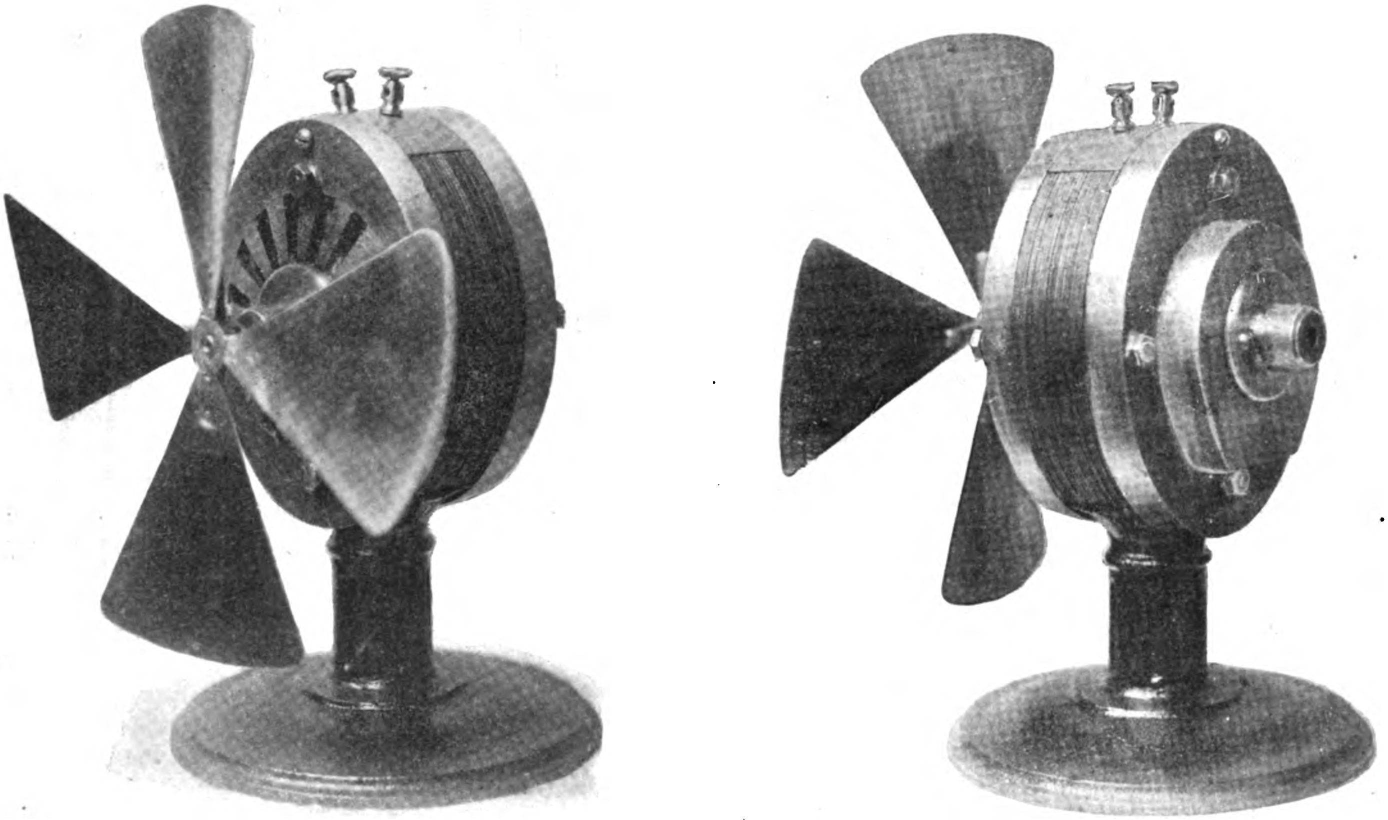
X.

At this point we may suspend the tour of observation, for while in the remaining floors above, the same attention to detail is seen, whether in sleeping apartments, nursery, school-room, kitchen or pantries, the devices are more familiar and time-honored. One must not fail, however, to mention that the central square formed by the stairs in the upper part of the house is beautifully lighted by a large stained glass skylight, which, owing to the lights concealed within it, is a prettier sight by night even than by day. The stairs themselves are masked by a high mahogany grille, but are brilliantly lighted in this way, not less than the broader flights below with their palms and draperies.

It is not to be supposed that all the happy and successful innovations in the use of electric light and power that have been described, are the production of a few hours or a few days. It is not to be supposed that these things can be had without money and without taste. Nor is it to be supposed that every wealthy citizen who wanted to be original in his methods of illumination could do what has been accomplished here. But it happens that in this case, the owner of the house, with abundant means to try such experiments, is a man of quick invention and a very long experience in electrical engineering. Mr. Johnson is an ardent believer in certain principles relating to the electrical arts, and here in his own home he has given the fullest expression to his convictions and the freest play to his taste and genius. As a consequence we have an object-lesson of the first importance, the study and mastery of which may teach us all there is to be known in the best modern methods of utilizing electric light and power in the House Beautiful.

THE GUTMANN ALTERNATING CURRENT FAN MOTOR.

With the approach of the heated term, the refreshing breeze of the little electric fan motor is looked forward to by many who have heretofore been unable to secure ventilation in small and confined apartments. Those who are within reach of, or distributing, the alternating current, especially, will be interested in the description of a new fan motor designed to operate on alternating circuits, and now being brought out by Mr. Ludwig Gutmann, of Pittsburgh, Pa. In designing this little motor, Mr. Gutmann has had in mind particularly the difficulties which have been encountered due to the fact that the brushes of such motors required frequent adjustment owing to the delicate contact necessary in order to avoid excessive loss due to friction at the commutator. When trouble did develop it was frequently aggravated by the meddling of unskilled persons.



The Gutmann Alternating Current Fan Motor.—Front and Rear View.

The problem of obviating this difficulty may be attacked from either a mechanical or an electrical standpoint. The former plan was adopted by Mr. Gutmann, and led him to the construction of the motor shown in the accompanying illustrations. The inventor has set himself the task of building a simple alternating current motor, requiring little attention, whose brushes could not get out of adjustment, and would be difficult of access to the unskillful user.

The motor belongs to the induction type, having its field coils permanently connected to the two terminals of a circuit or lamp socket of 50 or 100 volts, while the armature has no electric connection with its field. The armature is of the drum type located between the two field poles, and is provided, as usual, with a commutator on which rests a brush of peculiar construction. This is a modification of the brush patented by Mr. Gutmann, in which a low resistance conductor is placed between two conductors of high resistance, thus presenting a good conductor in contact with the commutator, and a high resistance contact on the side where the segments leave the brush.

The brush is of horseshoe shape subdivided in a plane at right angles to the axis of the armature, and supported by a bolt or arm above the commutator. About half way between this arm and the free ends of the brush are internal projections, supporting carbon blocks on one side and making contact with the commutator. To insure proper contact at all times the horseshoe brush is divided into two parts and hinged on the support, at the opposite side of which the tension is applied by means of a spring. The brush cannot be shifted, and as long as there is anything left of it the motor will operate. The brush is designed to operate by gravity alone, but for the fan motors it has been thought advisable to add the spring. It is intended to omit the latter on the larger machines.

A glance once a fortnight is all the inspection required by this motor. The brush is encased out of sight and out of reach of ignorant or meddlesome persons, the bearings are self-lubricating, and the liability of getting out of order is reduced to a minimum.

PRIZE ESSAY ON THE TRANSMISSION OF POWER BY ELECTRICITY WITH SPECIAL REFERENCE TO ITS APPLICATION TO MINING.

An Alumnus of the School of Mines of Columbia College of New York has offered a prize of $100 for the best essay on the above subject that may be presented by a graduate of the school. The essays must be sent to Prof. W. P. Trowbridge on or before Nov. 1, 1892. President Seth Low will appoint a committee to examine the essays and award the prize. The successful essay will be published in the *School of Mines Quarterly*.

Mr. J. Elliot Smith, the superintendent of fire-alarm telegraphs of New York, has been appointed superintendent of fire-alarm, telegraph and appliances in the new Building Department.

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VOL. XIII. NEW YORK, MAY 25, 1892 No. 212.

From a want of knowledge of the state of science and a due consideration of the proper time and place, many ingenious minds have wasted their energies in fruitless labor, waged with fortune an unequal war, and sunk into the grave the victims of disappointed hopes.—Joseph Henry.

ELECTRIC LOCOMOTIVES FOR SHORT STEAM ROADS.

IT must be evident to all who watch the development of electric railway work that the point has been reached at which the substitution of electricity for steam on short steam railroads ceases to be a matter of discussion and enters the stage of practice. The departure is by no means as strange and revolutionary as it will certainly appear to many people, for not a few of the larger street railways are doing work with their electric cars more than equivalent to the demands that are likely to be made anywhere except on long steam roads. In Boston, for example, or Cleveland and St. Louis, or between St. Paul and Minneapolis, the electric service is handling a passenger traffic much heavier than that on a large number of the "commuter" steam roads around New York, Philadelphia or Chicago. The main difference, after all, and that not a small one, is that each of the electric street cars is its own motor and is almost always restricted to passenger traffic, while in the new work, just beginning, the trains, both passenger and freight, are to be handled by heavy locomotives, following in many respects the best precedents that the magnificent art of steam locomotive-building can furnish.

After all, the stages of evolution by which we have attained the present point in electric railway work have been comparatively slow. Several years ago, Mr. Leo Daft built an electric locomotive work for Elevated Railway experiments in this city. The motor was of about 125 h. p. and behind it the present writer more than once made the best speed he has ever seen on the Manhattan system. In 1886, Mr. Frank J. Sprague made some very interesting experiments on the same road with trains of individual motor cars, and also began the construction of a double bogie truck car, each axle driven by a 75 h. p. motor, making a 300 h. p. equipment, and weighing with the car and passengers about 30 tons. In 1886 also, Messrs. Bentley & Knight and the Rhode Island Locomotive Works made plans for a 670 h. p. electric locomotive. These plans were published in Martin & Wetzler's work on the electric motor, at the time, but, we believe, were never put into execution. More lately, the City & South London underground road has been operating with electric locomotives of about 100 h. p., made up by a 50 h. p. motor driving on each axle; and a few months ago, the Thomson-Houston Co. built a locomotive of about 125 h. p. for freight service at Whitinsville, Mass. That locomotive, on trial, handled a train of 4 to 6 heavily loaded cars, or an aggregate load of 200 to 300 tons, at a speed of 5 miles an hour on a level.

It might be said, with truth, that all this preliminary work does not touch the main issue, the practical substitution of electricity for steam on a regular steam road,—but the new day has arrived, and we are glad to make note of two highly important events marking the initial steps of the change. Perhaps Mr. Henry Villard, the president of the North American Company, always a shrewd and enthusiastic believer in the possibilities of electric traction, deserves the credit for making the first contract for electric locomotives on a steam road. He has been anxious to improve the facilities around his Northern Pacific terminals in Chicago, and more than a month ago, it is understood, made an agreement with Mr. Sprague for an electric locomotive of not less than 700 h. p. to handle the traffic. The Thomson-Houston Company will also, it is said, build a locomotive of similar capacity for the same work.

Following quickly upon this action of Mr. Villard, comes the news of the determination of the Baltimore & Ohio Railroad Company to equip the tunnel of the Baltimore Belt Railroad with electric locomotives and the necessary power plant. Although various reports have been published as to the details of this work, it was not until the close of last week that the details of the contract were finally settled. As far as can be ascertained, the contract involves the building, for delivery early next year, of three 80-ton locomotives, which are to develop, approximately, a drawbar pull of 31,000 pounds at 15 miles an hour. A station of about 2,500 h. p. will be installed with four units and direct-coupled engines and generators. This station will be midway in a run of 12,000 feet. The maximum work required of each locomotive in developing this drawbar pull is to move a 1,200-ton freight train over a grade of about eight-tenths of one per cent. at 15 miles an hour; and, in passenger service, to move a 500-ton train at 30 miles an hour over a similar grade. Each locomotive will also be expected to serve as a reserve or assistant engine for the regular steam locomotive just outside the tunnel, when the latter is hauling a freight train up a grade of $1\frac{6}{10}$ per cent. All told, there will be about 200 trains a day of each class. The tunnel is also to be lit by electricity.

Our readers will at once see that in Chicago and Baltimore electricity is to be put to some of the heaviest traction work yet encountered, and they will share with us the conviction that the new motive power will be more than sufficient for the demands thus made upon it. Personally, as New Yorkers, we could only wish that the New York Central saw its way to taking part in this work, so that its tunnel leading to the Grand Central Depot might be redeemed from its present mephitic foulness and gloom. It seems to us that Mr. Twombly, who has now happily transferred to electrical work a part of his time and energy, as an executive officer of the General Electric Co., must have it borne in upon him that while he is thus making contracts with roads South and West he might do a good stroke of business and earn the gratitude of every citizen of New York as well as everybody who comes in over the great Central system, by making the Harlem tunnel as sweet and cheerful, by the aid of electricity, as Fifth avenue is on one of these bright May days.

THE ELECTRIC CLUB OF NEW YORK.

The new Board of Managers of the Electric Club of this city in taking up and continuing the special work of its immediate predecessor in straightening out the finances of that institution is showing an activity and devotion that should entitle it to the fullest support and sympathy of the entire electrical community. Not only has it already done wonders in lifting the load of indebtedness, but it has begun to rally support to such an extent that 22 new members have been admitted during the present month. This is a bright augury, and if every member saw to it that he brought in one eligible candidate, the club would soon be in a very prosperous condition. As a social institution, a common centre for a large variety of interests, the club has done a great work and still has a well-defined mission. Its purpose is of the highest and the fine old house in East Twenty-second street has seen many a bright and pleasant gathering. Next year we shall have a large influx of electricians from abroad, and steps must soon be taken for their appropriate reception. In this work, as in many other things, the Club and the Institute might well join their forces. We are glad to learn that the club will celebrate its present cheering outlook with an entertainment on Friday night, and trust that the attendance will be the largest ever seen within its hospitable portals.

ELECTRIC HEATING.

Our contemporaries devoted to the recording of advances in engineering work, have for some time found much interesting matter to occupy their columns in the application of electricity in various forms. Among these applications, electric heating and electric heaters have of late been given special prominence and have, in more than one instance, been the subject of critical discussions as to their efficiency. Readers of this journal may recall our comments on an article of this nature, which appeared in our excellent contemporary, *The Engineering News*, some time since. That paper attempted to show, that considering the low heat unit efficiency of a system of electric heating, its application, even on the smallest scale, was practically out of the question. We are glad to note, however, by the appearance in its columns of an article on electric heaters, that this useful apparatus is now shown to have a field comparatively narrow, though it may be almost infinitely long. When there is daily evidence of the adoption of electrically heated tailors' "gooses" by the proprietors of the so-called sweating shops, "it is reasonable to believe that electric heating can be used with decided economy." And the writers also go on to show that wherever the conditions prevent the use of the oil or gas stove, and preference is given to appearance and convenience rather than to economy, it may come into play. This is exactly the position we have maintained on this matter from the beginning, holding that there are many instances and conditions which make electric heating desirable and economical.

CARBON.

Modern electrical engineering, and this term is here used in a comprehensive sense, is so largely dependent upon copper as the transmitter of the electric impulse of whatever nature, be it for lighting, power, telegraph or telephone, that one scarcely realizes the important position which another material has assumed in the same art. This material is carbon, of which it may truthfully be said that, without it, both electric lighting and telephony would still be largely in the experimental state. For, despite the obvious short-comings of carbon in the form of the pencil employed in the arc lamp, or of the filament as we find it in the incandescent lamp, it still holds its own in those fields against all comers. And while we have also been promised substitutes for carbon in the telephone transmitter the fact remains that carbon is used to-day, and it is safe to say that if a better material were available it would be used in practice. That carbon still has a field before it in other electrical applications is well illustrated by the fact that we note a new use for it, and this time in a direction which would hardly have been expected. Cable telegraphy so rarely experiences an advance that any improvement worthy of the name is deserving of special notice ; hence the new carbon relay for submarine cables, described by Mr. Charles Cuttriss on another page, will be of interest, as it embodies a construction which for the first time permits of cables a thousand miles in length being operated by relay without necessitating local hand repetition.

The Kelvin.

Electrical engineering has given opportunity for the coining of numerous words and phrases but that there is still a desire to avoid circumlocution in electrical literature is shown by the recent formal adoption by the English Board of Trade of the term "Kelvin," to express the Board of Trade unit of electrical energy, 1,000 watt hours. As a compliment to, and a recognition of the electrical services, of Lord Kelvin, the new term will, without doubt, be speedily adopted. There has been some complaint against the coining of so many new words in electrical nomenclature, but we are among those who believe in brevity, when clearness is not sacrificed thereby ; and in the present case there can certainly be no confusion with any other unit thus far proposed. It may be easy to make fun of these units, but they will outlive the joke.

THEORETICAL ELEMENTS OF ELECTRO-DYNAMIC MACHINERY—V.[1]

BY

A. E. Kennelly

POTENTIAL DISTRIBUTIONS (*Continued*).

FIG. 8 represents a plane section through the axis COD of a circular loop of wire AB carrying a current[2] and the traces of 24 equipotential lines. If the diagram be rotated about the axis COD, these lines will generate the corresponding system of lenticular equipotential surfaces. These commence at the surface of the wire, and are all finite except the plane AOB which may be extended indefinitely. The case applies practically to a single-ring tangent galvanometer, and in order to make the particular equipotential surfaces here indicated correspond to successive integers, the current in the ring must be 1.91 C. G. S. units or 19.1 amperes, circulating clockwise as viewed from C. The M. M. F. or total P. D. in the magnetic circuit will be $4\pi \times 1.91$, or 24 ergs per unit pole, and the surfaces are marked from + 12 to — 12, down grade in the direction of the arrow.

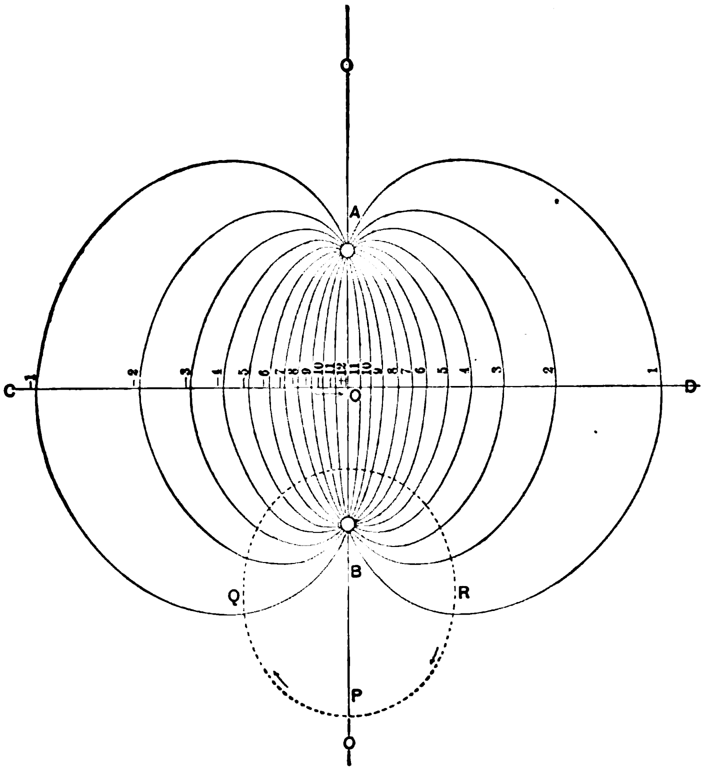

FIG. 8.

We have already seen that each equipotential surface must be so described, that from any point in it the solid angle subtended by the ring is the same. While this rule accurately defines the potential at any distant point from which the ring appears as a mere circular filament, it needs modification for those points nearer the ring where the solid angle subtended by its outer edge and inner edge differ sensibly. At these shorter ranges, it is necessary to suppose the ring divided up into a suitably large number of smaller and filamentary circles, each carrying its due share of the current. The sum of the solid angles multiplied by their current for all these elementary rings will give the resultant potential. The same reasoning applies to a coil of any shape made up with separate turns of insulated or uninsulated wire.

Starting from any point P on the plane AOB outside the ring, the surface of the ring vanishes to the eye of an observer at this point, so that the solid angle and potential are here both zero. As we proceed down grade along the dotted line of B cutting the successive equipotential surfaces at right angles, the ring opens into view, and the solid angle,—its area of projection on a unit sphere—increases, but the direction of the current appearing clockwise, the potential is negative. It continues to increase numerically until the interior plane AOB of the ring is reached, when its projection will embrace just half the surface of a unit sphere, making the solid angle 2π, and the potential $-2\pi c = -2\pi \times 1.91 = -12$. The instant, however, that the central plane is passed, the aspect of the ring changes, and the current appears to circulate counter-clockwise. The potential is now positive and + 12 (the solid angle being still 2π). At the passage of the median plane, there has been an abrupt cyclic elevation of potential of $4\pi c$, without any discontinuity in the gradient on either side of the ascent.

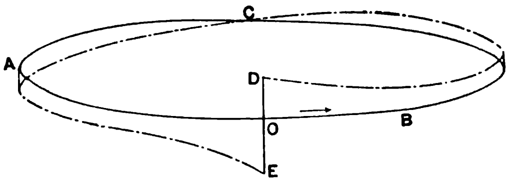

FIG. 9.

This distribution of potential is depicted diagrammatically in Fig. 9. ABC is the perspective view of a horizontal loop, an elementary magnetic circuit and individual line of flux such as PQR in Fig. 8. The vertical distance of the line DCE above or below, marks the potential at each point of the circuit. The gradient of the line DCE has everywhere a definite value, and numerically equals the intensity *B*. At the point O corresponding to the interior plane AOB of Fig. 8, the potential rises abruptly from E to D through $4\pi c$ units, the gradient just before F, and just after D being the same.

This is precisely analogous to the conditions that would be established if ABC were a galvanic instead of a magnetic circuit, with a battery of $4\pi c$ volts at O, except that galvanic circuits are usually closed through insulated wires of uniform cross-section and conductivity, that impose a uniform gradient or drop in electric potential. If the circuit were metallic—not completed through the ground—the potential would start at the copper pole of the battery with a value of $+ 2\pi c$ volts and would fall in one circuitation to $- 2\pi c$ volts at the zinc pole, assuming that the internal resistance and consequent drop of potential in the battery were negligible. There would be a cyclic elevation of potential in the battery of $4\pi c$ volts.

Fig. 10 represents a similar magnetic circuit ABC threading two rings of wire, each carrying a current of *c* units. The M. M. F. in the circuit will here be $2 \times 4\pi c$ or $8\pi c$ ergs per unit pole. There are two discontinuities of potential, at B, and at D, while the average gradient is twice as steep as in the preceding case. It will be noticed that all discontinuity might be avoided if the potential

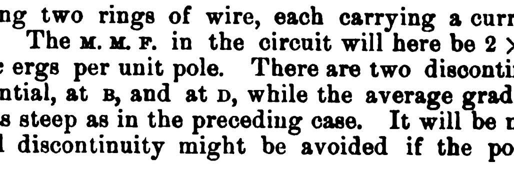

FIG. 10.

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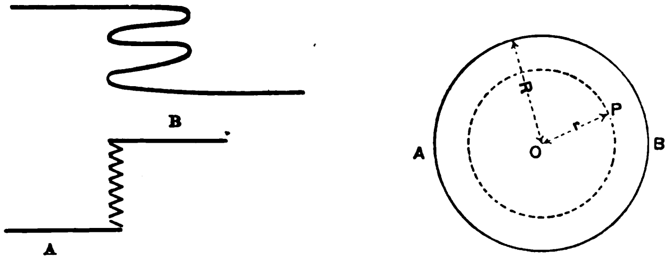
[1] Copyrighted 1892 by A. E. Kennelly.

[2] J. Clerk Maxwell, *Electricity and Magnetism*, Vol. II., Plate xviii.

line at F continued along the dotted line towards G instead of rising to the new level, but by pursuing this course, it would continue to generate a spiral whose successive convolutions would be $8\pi c$ units apart. The potential would then be continuous but multiplex. Similar conditions would apply to the galvanic circuit, but for the fact that all electric potentials are conventionally measured relatively to that of the ground in the vicinity, which precludes multiplex values and makes cyclic discontinuity the necessary alternative.

In passing along a magnetic circuit through the spires of a coil or solenoid conveying a current c, there is a cyclic elevation of potential equal to $4\pi c$ at the plane of each spire. For two spires the elevation would evidently be of the type shown in Fig. 11; for a larger number of closely associated turns, the line of elevation instead of being abrupt would appear to have a definite gradient, A B, Fig. 12, namely, $4\pi n c$, n being the number of turns per centimetre of circuit. This explains why the flux, in Figs. 4 and 5, of Chapter III appears to move up grade, contrary to rule, within the solenoid and sphere. The apparent anomaly is due to the continuous superposition of small cyclic elevations, and the potential may be considered to descend uniformly, but to be increased by $4\pi n c$ per centimetre of coil. A similar apparent reversal of current against potential takes place in a series of cells supplying a galvanic circuit.



Figs. 11, 12 and 13.

Returning to Fig. 8, the solid angle at any point on the axis C O D distant x centimetres from the centre O, is readily found to be $2\pi\left(1 - \frac{x}{\sqrt{x^2 + r^2}}\right)$, r being the radius of the circle A O B, and the cross-section of the wire being so small that the current may be considered filamentary without practical error. The potential is therefore

$$P = 2\pi C\left(1 - \frac{x}{\sqrt{x^2 + r^2}}\right).$$

The gradient of this or $-\frac{dP}{dx}$ is $\frac{2\pi C r^2}{(x^2+r^2)^{\frac{3}{2}}}$, and numerically equals the intensity B at any point on the line C O D. At the centre O where x is 0, B becomes $\frac{2\pi c}{r}$. A ring set in the magnetic meridian, and employed as a tangent galvanometer superposes on the earth's intensity in the line A O B, the intensity $\frac{2\pi c}{r}$ at O directed along C O D, and a small magnetic needle placed there will set its magnetic axis along the resultant of these two rectangular fluxes. If θ be the angle of deviation we must have

$$\frac{\text{coil's intensity}}{\text{earth's intensity}} = \tan\theta = \frac{\frac{2\pi c}{r}}{H},$$

H being the earth's horizontal intensity; from which $c = \frac{H r \tan\theta}{2\pi}$ the usual tangent galvanometer formula.

The solid angle and potential of the ring cannot be so simply expressed for a point not situated on the axis of the ring. Although there are several methods for evaluating them, all involve the use of convergent series whose terms have to be summed until the desired approximation is attained.[1] It is evident from the figure, however, that on the median plane A O B, within the ring, the intensity is a minimum at the centre O for the equipotential surfaces — 11 and + 11 are furthest apart at that point; yet as regards the axis, B is a maximum at O, for along O C or O D the surfaces separate out as they recede from the median plane.

The total flux threading the wire, or the surface integral of B, is also a complex expression. It increases directly with the linear dimensions of the loop, for by doubling the scale of the diagram, the distance between the equipotential surfaces will everywhere be doubled, halving B everywhere, but quadrupling the area through which it flows, leaving the aggregate flux twice as great.

It is worth passing attention to notice the distribution of flux in a case where there is no system of potential, — the interior of a current-conveying conductor, — as already mentioned. Let R be the radius of a circular wire over whose cross-section A O B, Fig. 13, the current is uniformly distributed. At the axis O, there is no flux, but from this point outwards the flux steadily increases. At any point P, distant r from O, the current in the external cylindric shell of radii R and r, produces no influence, and the intensity is that which would be produced at the surface of a wire of radius r having the same current density. This intensity from what we have seen in Chapter II would be

$$\frac{2c}{r}\left(\frac{r^2}{R^2}\right) \text{ or } \frac{2cr}{R^2}.$$

The flux takes place in circles all concentric with the axis of the wire. The M. M. F. in any circle of flux is $4\pi c\left(\frac{r^2}{R^2}\right)$, but this cannot be distributed potentially so that the gradient shall coincide with B.

MODERN AMERICAN TELEGRAPHIC APPARATUS—II.

BY

F. W. Jones

SINGLE TRANSMITTERS AND SOUNDERS.

To C. A. Nystrom, of Sweden, is accorded the credit of having invented the continuity-preserving key as early as 1855, and it was variously used in attempted duplex telegraph transmission by early experimenters, including Moses G. Farmer, who applied the principle to a polarized differential duplex system in 1858.

The continuity attachment in all cases had been attached directly to the key until 1868 when J. B. Stearns employed it probably for the first time combined with an ordinary sounder so that it could be independently operated by the key, permitting the operator sending to hear his own signals the same as when working a single Morse wire.

In 1872 the Western Union Telegraph Company introduced the Stearns duplex system very extensively on its wires and the Stearns sounder transmitter was used until 1873 when it was superseded by the pattern shown in Fig. 1, which notwithstanding its serious mechanical defects held almost universal sway until 1889 when the improved transmitter shown in Fig. 2 was adopted by the Postal Telegraph-Cable Company.

Refering to Fig. 1, the spring C is made of a thin piece of flat steel known as clock-spring attached rigidly to a rubber block mounted on the end of lever B and so bent that it makes electrical contact through platinum points with a hooked projection of the lever when the latter is released by the electromagnet, and with the battery post D, via contact C, when the lever is in its closed position, as shown in Fig. 1.

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[1] Professor Perry: *Phil. Mag.*, Dec., 1891.

In practice this spring frequently gets bent or loses its normal elasticity or harbors a particle of dust or oxide, so that a very minute opening of the contact, or an imperfect vibratory contact results at the point X. The position of this defect is so obscured and the characteristics so similar to an opening in the battery or other part of the circuit that the average chief operator is baffled in a speedy location of the trouble.

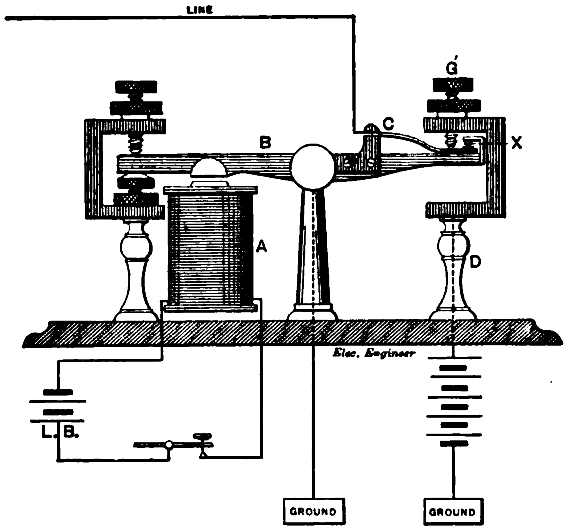


FIG. 1.

Various manufacturers differ in the size and quality of the steel and, as furnished, the spring C varies greatly in its tension; moreover it is non-adjustable and cannot be adapted to the inevitable variation of the battery current from L B in the electromagnet A that operates the lever B.

There is a tendency of a rebound between spring C and end of G', and it is very instructive to the electrician to use a telephone in testing the operation of transmitters as it will show how fallacious are the conclusions based upon the eye and theory in such matters.

This transmitter has yet another drawback in not possessing clear-sounding properties with ordinary local currents, as the lever is arrested in its downward stroke by the resistance of spring C at end of G' and there is an impairment of the sound which should be loud and clear for the benefit of the sending operator or attending chief operator. The difference in sound when C is removed is very marked.

In the apparatus shown in Fig. 2 the foregoing disadvantages have been almost entirely eliminated. Here lever B on its down stroke clears the supplemental lever C, relieving it of the vibration set up in B, and at the same time giving an unmuffled sound. The contacts at E and X can be regulated to be made with equal pressure by the lever at any workable strength of current in the electromagnet M.

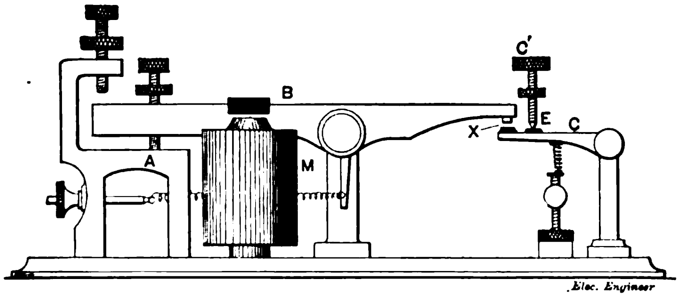


FIG. 2.—POSTAL TELEGRAPH-CABLE SOUNDER-TRANSMITTER.

A peculiar feature of American telegraph systems is exemplified by the very large use during the past decade of sounders and transmitters having electromagnets of ridiculously small proportions, the prevailing size having bobbins about 1¼" long and 1" diameter, over all. The standard size of each bobbin adopted by the Postal Telegraph-Cable Company is 1½" long and 1¼" diameter (over all) in which coarser wire may be employed.

A comparison of the two magnets, each wound to 20 ohms with a continuous current of 125 milliamperes shows the 1¼" × 1" magnet to have an inductance of 191 millihenrys and a time constant of .0095 second. The 1½" × 1¼" magnet has an inductance of 130 millihenrys and a time constant of .0065 second with the armatures 4 mils from the cores. The latter magnet has nearly twice the pull at the armature with a given battery, and its larger time constant is not serious enough to be noticeable.

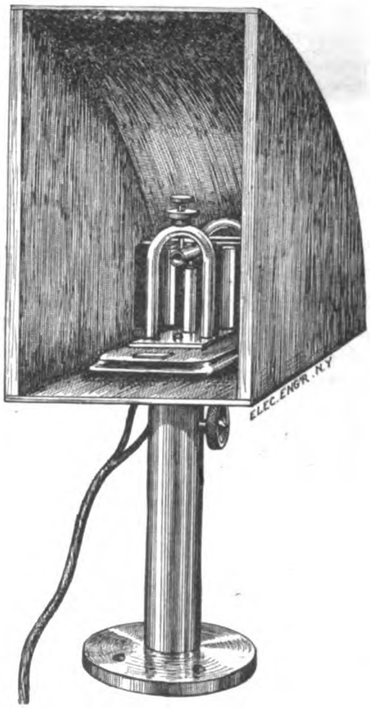

ELEC. ENGR. N.Y.

FIG. 3.—THE POSTAL TELEGRAPH RESONATOR.

The adoption of typewriters by the Postal Telegraph-Cable Company for the reception of its messages introduced a disturbing sound from the clatter of the keys of the machine. This makes it necessary to obtain distinct and loud sounds from local instruments, and enlarging the bobbin contributes to this and without additional expenditure of energy.

Fig. 3 is a resonator I have recently introduced similar to those used in the postal telegraph service in England but smaller and better adapted to our service. It is placed on the table to the left and near the receiving operator and the sounder is placed inside and connected by a flexible cord which passes through a hole in the bottom near the upright standard. The resonator is turned so that the volume of sound is thrown in the direction of the receiving operator who (on a quad table) sits on the left of the sending operator. Thus both are enabled to hear while the sound is screened from all other directions.

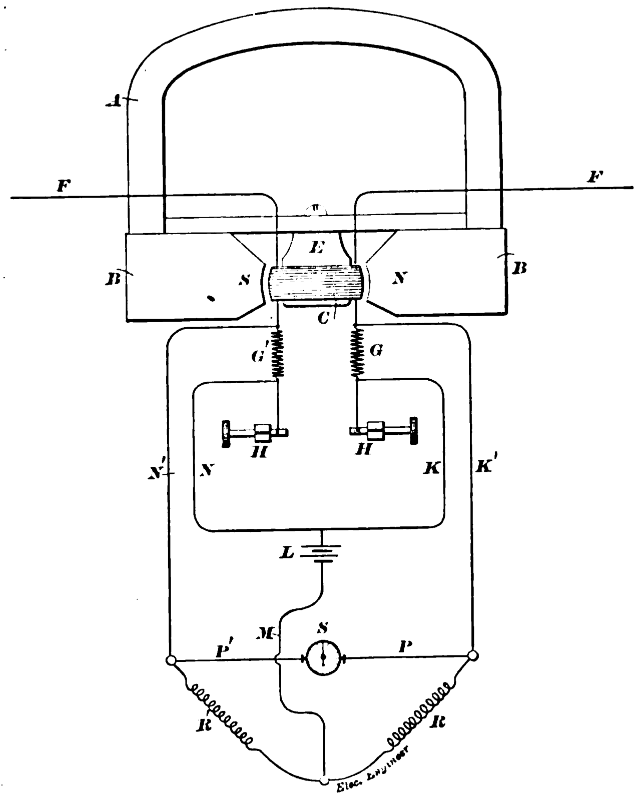
A STRANGE case of one-way conduction, says *Industries*, is mentioned by M. E. Branly. Hot gas conducts—as is well known—but with one electrode cold it conducts best when that electrode is negative. This phenomenon is probably intimately connected with that recently discussed by Dr. Fleming in his Royal Institution paper on the phenomena of discharges in incandescent lamps.

THE CUTTRISS CARBON RELAY FOR SUBMARINE CABLES.

BY

Chas Cuttriss

Until within a comparatively recent period telegraphy was the most important branch of electrical engineering, but of late years developments in electric lighting, power and traction have been so marvelous and we have become so accustomed to calculate and think of volts and amperes by the thousands and tens of thousands that the mind has to exert itself somewhat to realize that instruments using only the hundred-thousandth of an ampere for a maximum current and a millionth of an ampere for a minimum current, are in daily use, and that by means of them we annihilate time and link together the Old and New Worlds.



The Cuttriss Carbon Submarine Cable Relay.

Nevertheless, this is a fact, and by means of these minute currents communication at the rate of 25 words per minute is steadily maintained over the Atlantic cables for hours at a time. That this may be done it has become necessary to abandon to a great extent the old system of manual transmission and to adopt an automatic mechanical transmitter, so that we can now insure the same perfection as regards the shape of the signals and the required spaces, at the end of a twelve or twenty-four hours' run as we had at the start.

A few years ago the public were content to send a message to London and get an answer within an hour; now they can get it in a minute or two; but still the cry is for quicker communication. As the adoption of the automatic system of transmission has increased the carrying capacity and speed of long cables to the utmost we can only hope for still more rapid communication between terminal stations by saving the time now lost in the necessary retransmission of messages at intermediate stations. This, of course, can be done by interposing a relay which shall automatically repeat into the second cable the signals which come over the first one. As all signals over a submarine cable of any length are of an undulatory character, it becomes necessary that this relay should repeat these undulations into a local circuit as faithfully as a telephonic receiver reproduces the undulations of the diaphragm of its transmitter.

After many failures to attain this end during the last ten years, the instrument shown diagrammatically in the accompanying engraving has been invented by the writer. By its means the connecting in series of a number of short cables of about 800 to 1,000 miles in length or the connecting of a short cable to a long one is perfectly feasible. Up to the present time a relay known as the Allen & Brown has been practically the only one that would work Morse over cables 500 miles long, and with cables of this length the utmost delicacy of adjustment was necessary to obtain satisfactory signals.

Heretofore there has been no instrument which would repeat recorder signals into a local circuit, thereby making it possible to have several offices in a city working directly on to a through cable after the manner in which Morse instruments at various offices work onto one trunk line. In the spring of 1889 I first obtained reliable recorder signals in a local circuit by means of a repeating relay in circuit with the Commercial Cable Co.'s Canso-New York cable, the copper resistance of which is 13,600 ohms, with an electrostatic capacity of 233 microfarads and a length of 855 knots; the cable is duplexed, and a battery power of 30 volts is used for signaling.

The relay was crude and consisted of a coil of peculiar shape, which carried two small carbon discs and which moved in a magnetic field; this coil was placed in the cable circuit. Opposite to the two discs were carbon points, which were connected in a local circuit to the receiving instrument, consisting of two ordinary 8-inch horseshoe magnets, between the poles of which a small coil carrying the syphon was pivoted, the syphon dragging over the surface of the paper.

When the operator at the distant station sent signals, to my surprise they were recorded on the receiving instrument perfect in shape and character, and subsequent measurements showed that the power in the local circuit was upwards of fifty times as great as the initial cable current. Since then I have experimented in every way to find the best form of contact points, but have finally rejected points of any shape as the adjustments had to be too delicate and the points showed a great tendency to stick and burn.

I then turned my attention to making helices of carbon and found that by substituting them for the adjustable points all the troubles incident to sticking and burning were eliminated, and that they gave a variable circuit that is entirely under the control of the movable coil. The relay now repeats most minutely all the undulations of the cable currents.

The strength of the currents in the local circuit can be augmented to such a degree that the local instrument requires no delicate parts and can be adjusted by the operator instead of requiring the services of a skilled mechanician.

As will be seen, N S are the poles of a permanent magnet; E is an iron core situated between them so as to concentrate the lines of magnetic force into two fields in which a coil C is pivoted at the top and bottom. Thus far the instrument is a copy of the syphon recorder, but instead of using metal springs, weights or analogous devices, to bring the coil back to zero after it has been deflected by a signal, I have substituted the carbon helices G G', connected to the coil by fibres or otherwise, and it will be readily seen that any deflection of the coil must open one spiral and close the other.

Normally the circuits, M, R', R, K', N', G, G', N, K and L are so balanced that there is no difference of potential at the extremities of the wires P and P'; consequently the local instrument S is unaffected. Should, however, a signal be sent through the coil c it will tend to close one of the carbon spirals and open the other, thus throwing the local circuit out of balance and energizing the local instrument s to a degree corresponding with the movements of the coil; the amount of the energy thus developed follows the laws of the Wheatstone bridge.

By varying the resistances in the local circuit and the strength of the battery we can obtain any desired power in the local instrument, and, if necessary, a number of them can be placed in various offices in a city by means of the circuit P P′.

It was while experimenting with the instrument and observing the perfect manner in which the weak cable signals were reproduced by these carbon helices, that I was led to try them as a telephonic transmitter and was not surprised to find their action all that could be desired. The results obtained have already been described in these columns by the writer.[1]

Legal Notes.

FINAL HEARING ON EDISON'S "FEEDER AND MAIN" PATENT FOR ELECTRICAL DISTRIBUTION.—II.

THE DEFENDANT'S CASE.

The complainant has sought, with much persistence, to introduce considerations which seem to have no proper bearing upon the interpretation of the patent, but serve merely to obscure the real issue, hence it will be useful to state at the outset the defendant's view as to the real nature of the alleged invention of the patent in suit. The particular subject-matter with which the patent purports to deal is electric pressure or tension, and the alleged invention purports to provide a remedy for the drop or fall in electric pressure due to the resistance of the main conductors. It is practically impossible to formulate any intelligent definition of electric pressure or tension without recourse to fluid analogies, and such analogies are serviceable, not alone as illustrations, but because it is a fact generally accepted among scientific men, that so far as concerns the general laws of flow and distribution, electricity behaves in all substantial respects as if it were a fluid. The patent states that where the main conductors of a system of electrical distribution extend to a great distance from the central station and supply a large number of transmitting devices, there is inevitably a difference in tension between the various parts of the circuit due to the resistance of the main conductors. The specification says:

> "This may be partially remedied by making the conductors very large near or at the station, gradually decreasing their size or conducting capacity; but such plan only lessens slightly the ratio of fall."

The latter part of this statement is not true as a matter of fact. The difficulty could be entirely remedied, as admitted by complainant's expert, Prof. Chandler, by increasing sufficiently the size of the conductors. The patentee then describes the remedy he proposes for the difficulty by the use of special feeding conductors "having no translating devices connected therewith," and further on describes the manner in which the feeding conductors and the main conductors of the consumption circuit are to be proportioned, or, in other words, how their relative sizes are to be adjusted. The specification states in substance that the circuit consists of two essential parts, the "feeding conductors" and the "main conductors of the consumption circuit." It is obvious that by reason of the mere form of the circuit, irrespective of its proportions, any drop in pressure on the feeding part of the circuit cannot affect the relative pressure in different parts of the consumption circuit, or the relative candle power of lamps connected with that circuit at different points. The specification says that the main conductors "should be so proportioned that the drop upon them shall not exceed a definite small limit." No instructions are given here or elsewhere in the specification, as to how this result is to be secured. No instructions are given as to any definite proportions, either of the main or the feeding circuit, nor what the "definite small limits" is, nor what variation in candle power is permissible. Taking all the statements together, they merely direct the constructor to proportion the consumption mains (if he knows how to do it) in such a way as to bring the variations in pressure within such limits as he finds necessary or desirable, and to proportion the feeding conductors (if he knows how to do it) in such a way as to incur any drop in pressure along that he finds desirable.

Each claim of the patent is in terms for a single circuit, and the gist of each claim consists in combining such single circuit, feeding conductors for conveying electricity from the generator to the place where it is to be distributed, with a consumption circuit for distributing the electricity so conveyed to the various points to be so supplied.

Complainant's experts have made a strenuous attempt to show that there are certain broad limitations which sharply distinguish the circuit covered by these claims from anything which preceded it in the art. Professor Chandler contends that central station regulation is an essential part of the system claimed. Sir William Thomson insists that central system regulation is an important and indeed an essential part of the system he is discussing. They say that the circuit covered by the claims is a "comprehensive system" involving the use of "large numbers of incandescent lamps," with conductors extending "great distances" and covering "large areas" and involving the use of a "central station." But when asked to define these terms they are wholly unable to do so. The plant in the Dundee mill, referred to by Sir William Thomson as one of the best embodiments known to him of the feeder-and-main system, comprises 800 lights used for lighting a single building. When asked to define what he means by "a large number" of lights the best definition he can give is: "I should think a good many hundreds—one hundred scattered over a considerable distance." All these vague limitations elude analysis, and will not bear examination. They are part of a studied attempt to lend fictitious dignity to this alleged invention, and to conceal its true character as a simple engineering expedient, by attributing to it the merit attaching to all the work that Mr. Edison and others have done in electric distribution, and to convey the impression that it is something large, complicated, and difficult of comprehension, requiring inventive genius of a high order to accomplish. Defendant does not, (nor apparently does complainant) attribute importance to the limitation of the third claim, that the feeding conductors are to be connected to the centre of the main, as conferring patentability, although in the original application this was made the principal feature of the invention. The adjustment of relative size of the different parts of the circuit consists merely in making the feeding conductors of any size desired, and in making the consumption conductors sufficiently large to keep variations in pressure within such limits as may be desirable. The real issue, so far as patentability is concerned, is whether this circuit was new with Mr. Edison, or required invention in view of the prior state of the art. The *form* of the circuit was one which must necessarily exist in all cases where the lamps are at a considerable distance from the generator. Such cases frequently arise in practice and it could hardly have involved invention to arrange the circuit in the only way it possibly could be arranged. No specific proportion of feeding conductors is called for by either of the claims, and in any event it could require no invention to use small enough conductors to incur any loss of pressure that for any reason might be desirable. The only remaining question is, whether it would require invention to make the distributing conductors large enough to distribute the current with proper equality of pressure, and this, by the admission of complainant's witnesses, is the only issue in the case, so far as patentability is concerned. Mr. Jenks, in his New York Electrical Society paper, says:

> "The feeder principle of distribution * * * * is entirely original with Mr. Edison, the methods of the gas companies, which were closely followed so far as they were adaptable to the government of the more potent agent which we utilized, did not at the time of the application for the feeder patents include any analogous means of equalizing pressure."

This statement carries by necessary implication the conclusion, that *if* the methods of the gas companies had included any analogous means of equalizing pressure (as it has been shown that they did) Mr. Edison would have adopted them if he had known of them, and Mr. Jenks would not have considered the feeder principle original with Mr. Edison. Mr. Edison himself, in numerous published statements has insisted upon the analogy between his system and the gas and water systems. As a matter of fact, the methods of both the gas companies and the water companies did include strictly analogous and, in fact, identical means of equalizing pressure, and this is true to such an extent, especially of gas distribution, that the descriptions of prior gas systems in the testimony of defendant's witnesses, and in prior publications in evidence, would, by mere translation of the gas terms into the corresponding electrical terms, constitute a much better specification than that of the patent in suit, of the system of distribution covered by its claims.

It is conceded that the alleged invention of the patent in suit is applicable to the multiple arc system of distribution only, and has nothing to do with the series system; it is not, however, claimed that the multiple-arc system of distribution was invented by Mr. Edison. Nor was he the first to discover that the resistance of a conductor carrying an electric current produces a drop in the pressure or tension of the current. The effect of changes in the size and length of the conductor, and of changes in the strength of the current traversing it, upon the fall of pressure, were well understood by electricians long prior to 1880, and formulæ had been worked out for calculating the proportions to be given to a conductor for securing a definite fall in pressure with a given current. It has been abundantly proven to have been a part of the common knowledge of the art, that for economically transmitting large volumes of electric energy to long distances, conductors should be used of considerably less size than would be required for maintaining an approximately equal pressure along the entire line of the conductor, and indeed this is admitted by Professor Chandler.

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[1] The Electrical Engineer, Dec. 16, 1891.

The claims in suit are anticipated by prior publications an uses relating to electroplating and electrotyping, in which t multiple-arc system of distribution was employed. The necessity for equalization of pressure in these applications is fully as great as in electric lighting, as has been recognized for many years. Long prior to the date of Edison's alleged invention, the method of equalizing pressure described in his patent has been utilized, viz., making the distributing parts of the circuit of sufficiently thick conductors to avoid resistance, producing inadmissible differences in tension, and using conductors to transmit the circuit from the generator to the distributing conductors of any desirable size, without reference to the fall of pressure in them. The criticisms of complainant's experts as to the size of the apparatus, the length of the circuits, and the pressure of the current, are wholly immaterial to the question at issue, since it could manifestly involve no invention whatever to apply upon a large scale a principle which had been recognized and applied upon a small scale.

The British patent to Werdermann and the Werdermann article in the *Telegraphic Journal* describes a peculiar form of multiple-arc circuit which has become known in the art as the "reversed parallel" circuit. So far as concerns the *form* of circuit of the patent in suit, it is shown in these publications, since no fall of pressure in the feeding circuit can affect the relative candle power of the lamps connected with the other part. It is apparent that Werdermann's system was intended for distribution on a large scale and over considerable distances. The desirability of uniformity of candle-power is also recognized by him. Complainant's experts say that the vital difference between this system and that of the patent in suit is, that the former does not describe central station regulation. This is immaterial. The patent in suit does not describe central station regulation, and such regulation forms no part of its claims. Another criticism is that Werdermann describes an arc lamp, and proposes to use a current of low tension which would be unsuitable for wide distribution. This also seems quite immaterial. The gist of the invention of the patent in suit (if there is any invention) consists in the arrangement and proportioning of the circuit for securing uniformity of pressure, and this is not dependent on the kind of lamp or the tension of the lamp employed. Prof. Chandler's contention that it would require invention to use a lamp of higher resistance, and a current of higher tension for operating it in the Werdermann circuit, is of interest rather as showing to what shifts complainant's experts have been driven in an attempt to sustain a position legally untenable, than as requiring serious attention. Prof. Chandler thinks it would have required invention to use the Lane-Fox lamp in the Werdermann circuit, with a current of the tension specified by Lane-Fox for operating it. This, it is submitted, presupposes altogether too dense an ignorance, on the part of every one except Mr. Edison, of the commonest principles of electrical engineering.

There is no doubt that the French patent of Khotinsky describes the *form* of the circuit of the patent in suit. There is one part of the circuit, the two main conductors, to which all the lamps are connected, and there is another and distinct part of the circuit, the two wires connecting the magneto-electric machine to the main conductors, and to which no lamps are connected. It is specially to be noted that it describes the connection of the feeders to the centre of the main conductors, specified in claim 3 of the patent in suit. The only real issue in regard to Khotinsky is narrowed down to the point whether in using his form of circuit, under circumstances sure to arise in practice, it would require invention to make the main conductors of the lamp circuit large enough to be practically useful.

The Lane-Fox patents and publications are important, as showing an intelligent appreciation of the fact that fall of pressure was a difficulty which would be encountered in a multiple-arc system of distribution on any extended scale; that the difficulty was due to the same causes of resistance to flow in the conduits, which produced the same difficulty in gas distribution, and that therefore it could be dealt with in the same way in electrical distribution as in gas distribution. As a general remedy, applicable so far as practicable, he adopted from gas distribution the proper proportioning of the distributing mains, making them large enough to avoid any harmful pressure. Then by reason of the extent of the system, it became impracticable to make the mains large enough to entirely obviate the difficulty; he therefore adopted one of the methods used in gas distribution, that of automatic pressure-regulators. He does not describe the other method—equally well known in gas distribution—independent feeding mains with pressure regulators at the works; possibly because he was ignorant of it, but probably because he thought it was unnecessary. Lane-Fox's selection from gas methods turned out not to be a judicious one; the other one, that of independent mains, which Edison selected and described in the patent in suit, is better adapted to the requirements for electrical distribution, but both will accomplish the result, and both are borrowed bodily from gas distribution.

The Sawyer and Man patent of 1878 describes a multiple-arc circuit, identical in form with Fig. 2 of the patent in suit. The Sawyer and Man patent does not describe proportioning of the parts of the circuit, and hence the same considerations apply to this patent, in this regard, as to the Werdermann and Khotinsky patents.

That the elements of the combination of the patent in suit were all old, follows necessarily and as a legal consequence from the mere statement that they are elements of a combination, as has been shown by abundant authority. Moreover, the evidence shows in fact, that these elements were old and well known in the prior state of the art. This proposition remains entirely undisputed, except as to a consumption circuit, properly proportioned, forming one of the elements of each claim. This is admitted by complainant's expert, Sir William Thomson, to be old, or at all events to be such a construction as would naturally have suggested itself to a person skilled in the art; complainant's other expert, Prof. Chandler, made the same admission on cross-examination, and his subsequent attempt to take a different position is a flat contradiction of his previous testimony and is in any event wholly illogical. Such a consumption circuit was in fact described in the prior patent of Lane-Fox; was well known in electroplating, and would not in any event have involved any invention, but only the exercise of mere mechanical skill and judgment, in view of its well-known application in the strictly analogous arts of gas and water distribution, and the common recognition among electricians of the strict analogy between multiple-arc electric distribution and gas and water distribution. Furthermore, the proportioning of the consumption mains in the claims in suit was not described at all in the original application for the patent, and if it was not well known in the art, then the patent is for a different invention from that described in the orignal application, and therefore void. This is the logical result of the position Prof. Chandler endeavors to take in regard to the Lane-Fox patent. There is no escape from this dilemma: Either the claims of the patent cover an invention not described in the original specification, or the fourth element of the alleged combination, viz., a properly proportioned consumption or service circuit, was not in itself new at the date of the application, or of Edison's alleged invention, but had been described in the Lane-Fox patents and publications, or was otherwise known to persons skilled in the art.

It is further contended by defendant that there is no patentable novelty in the combination claimed. It is established by the evidence of complainant's own experts, that the combination covered by the claims of the patent in suit did not involve the exercise of invention, but merely of engineering or mechanical skill, in view of the state of the art at and prior to the date of Edison's alleged invention. The gist of the alleged invention consists in nothing more than the use of transmitting conductors, of any size that may be desirable, for construction or otherwise, to transmit the current from the generator to the place where it is to be distributed, and distributing conductors made large enough to distribute the current without causing by their resistance inadmissible differences of pressure. Complainant's experts admit that the use of such transmitting conductors was well known in the art, and that it would not have involved invention, but the merest engineering skill to use such transmitting conductors for supplying current at a distance for any purpose whatever. The only question left, therefore, is whether it would have involved invention to make the distributing conductors large enough under such circumstances. Sir William Thomson admits that such construction would have naturally suggested itself to a constructor at that time. Prof. Chandler admitted the same thing on cross-examination, but retracted it on redirect. As a matter of fact, the proofs show that such construction of the distributing conductors was described by Lane-Fox in his patent of 1878, and had been used largely in electroplating. The prior patents of Werdermann and Khotinsky undoubtedly described the *form* of circuit covered by the claims in suit, and the *proportioning* of the circuit in the manner set forth in the patent was a matter not requiring invention, but only the exercise of the merest engineering and mechanical skill and judgment at the date of Edison's alleged invention. If these claims are valid they preclude the public from using the forms of circuits described by Werdermann and Khotinsky, in cases frequently arising in practice, such as the lighting of a building from a generator some little distance away, in the manner which would necessarily be adopted by any engineer, unless he ignored the commonest expedients known in the art at that date.

The prior publications and uses relating to gas and water distribution constitute a complete anticipation of the claims of the patent in suit. All the points of difference between gas systems and electrical systems, insisted upon by complainant's experts are mere differences in detail, not in any way affecting the general principles on which the claims depend, and the general principles contained in both cases, especially so far as relates to the specific matters dealt with by the patent, are identical.

The system of distribution covered by the claims in suit is not a legitimate combination within the meaning of the patent law, but a mere aggregation, and therefore not patentable subject-matter. Two distinct functions are involved in the system of circuits described in the patent: Transmission of the electricity from its source to the locality where it is to be utilized, and distribution of the electricity among the devices there to be supplied. The system is therefore one of transmission *and* distribution; not one of distribution alone. The function of transmission is performed solely by the feeding circuit; that of distribution solely by the transmitting circuit. Each part of the circuit works after its kind, without reference to what occurs in the other part. This independence of function is recognized and even emphasized in the specification. There is no co-ordination of functions, and no unitary result, but a mere aggregation of functions and aggregation of results. This is not a mere technical point of law, but goes to the merits of the case. It is another way of stating that the various elements of the alleged combination are used to perform their recognized functions; with such results as would naturally be expected, because they were the ordinary results of the action of the parts. Such an aggregation is not patentable. It was doubtless to avoid this conclusion that complainant made such strenuous efforts to inject central station regulation into the patent, as an essential element of the combination, to furnish some connecting link giving apparent co-ordinate action to the parts, but the patent furnishes no warrant for this, and in any event it would not materially affect the question.

To create a further presumption of patentability complainant has tried to prove that the alleged invention supplied a long felt want, and was immediately recognized as a very important contribution to the art, but all the testimony of complainant's witnesses on this point is a studied attempt to confuse the *specific* problem of equalization of pressure, with which the patent purports to deal, with the *general* problem of producing a comprehensive system, capable of supplying the electric light for general illumination. It is a fact that this general problem was a very difficult one and was universally so considered, but it is not true that the specific problem of the patent in suit was regarded by any one prior to Edison's alleged invention except perhaps by himself and his associates, as involving any invention whatever. The testimony of complainant's witnesses is, that no experiment was required for making the alleged invention, but on the contrary Edison proceeded, without making any experiments whatever, to embody the system of circuits in a large and extremely costly plant in New York City. This would indicate that so far as he was concerned, the applicability of the scheme to an incandescent lighting system was quite obvious, without experiment, as soon as the occasion arose for using it.

The history of the application of the patent in suit, as revealed by the proceedings in the Patent Office, shows that an amendment of a radical nature was made more than two years after the application was filed; made by the attorney without any oath from Mr. Edison or any one else; that the element containing the very gist of the claim, viz., a properly proportioned consumption circuit, was not described at all in the original specification, but appeared for the first time in an amendment filed by Mr. Edison's attorney. In the original application the principal features of the invention were: 1. Having no lamps on the feeding conductors; 2. Feeding conductors to tap the lamps of these conductors at their centres; 3. Lamp-circuit conductors to taper from the centre to the ends; 4. Lamps placed on circuits derived from lamp centres only. By eliminating the central connection of the feeders, not only was the scope of the invention materially broadened, but the very corner-stone of the invention, so far as concerns equalization of pressure in the lamp circuit, was removed bodily. The tapering of the lamp-circuit conductors, an essential part of the original statement of the invention, was also eliminated in the amended specification. The changes in the specification were necessarily radical, because the claims in suit could not have been supported by anything found in the original specification. Mr. Brevoort undertakes to say that "the file-wrapper all through describes and explains the invention set-forth in the first three claims in the patent." Complainant's case on this point is perhaps not helped by this opinion under oath on a question of law, and it may be remarked in passing, that the particular expert selected for this purpose is one who has had no practical experience in electric lighting and who is least acquainted of all complainant's experts with the art. On his own showing he has made no examination of the literature of the subject and has no familiarity with it, and hence has no special competence to instruct the court even upon the technical points involved. None of the other experts have undertaken to verify this proposition of law. The amendment in fact constituted a description of a new invention, not described at all in the original application, which is made a constituent and essential ingredient in each of the claims in suit. There is therefore, a fatal variance between the present claims and the original application, and the claims are for that reason void.

Futhermore, prior to the filing of the real application of the patent in suit, viz., the amendment filed August 1882, Edison took out another patent in which the invention now claimed is described but not claimed. By this description in a prior patent, the patentee and his assignee of both patents, the complainant, is estopped in asserting any novelty for it in this patent, hence the claims in this patent are void for this reason also.

The evidence on the issue of infringement is very conflicting. The complainant has not only failed to sustain the burden of proof, but the preponderance of evidence shows a construction of the circuits of defendant's plant which would not, upon any admissible interpretation of the claims be covered by them.

It is respectfully submitted that the bill should be dismissed with costs.

Letters to the Editor.

THE LONG-DISTANCE SYSTEM.

REFERRING to Mr. F. W. Jones's letter in THE ELECTRICAL ENGINEER of May 18, it is a fact that on various occasions talking has been carried on in this country over lines whose value expressed in KR considerably exceeded 10,000. According to the formulæ, we are told that when the value of the loop exceeds 10,000, or for a copper metallic circuit 40,000, the speaking "commences to become difficult." It may go on becoming difficult for a considerable addition of KR without becoming altogether impossible—when special experiments are made by experts. We heard the other night at the Institute dinner from Mr. Lockwood that experimental success is something quite different from commercial success, and it is pretty well known that telephone experts can talk over lines that non-experts can do nothing with. I do not think I can be held personally responsible for the success of any experiments undertaken by the Long-Distance Telephone Company; I merely recorded that such experiments had been made with a certain amount of experimental success. Doubtless the commercial success will follow later.

It is difficult to please Mr. Jones. First, he has his little fling at the length of the article, and then he complains that it was not longer and did not contain tables of sags and stresses, diameters of poles and other text-book information. He might have pointed out other omissions of a similar character, but your columns could scarcely be spared for a technical treatise on telephony; the article was intended merely as a general description of the Long-Distance Telephone system. To make it include the specifications that Mr. Jones asks for, would be to start out on different lines altogether and write a book instead of an article. If Mr. Jones really needs the information, the engineer's office of the Long-Distance Company is the proper place to apply to—it is all there. As to the splice, it is mentioned on page 448 near the bottom of the second column.

Regarding what Mr. Jones says about the "unwarranted belittlement of neighbors," I do not think he makes out much of a case. I stated very distinctly that the Long-Distance lines had had their breakdowns after extraordinary storms; I did not refer to the fact that telephone poles had been laid low in New York City by the snowstorm in January of last year, because that had nothing to do with the case. The fact remains, however, that there is no other overhead construction in this country to be compared with the Long-Distance lines, and further, that on many occasions when all telegraph service is interrupted by stormy weather the telephone service is maintained without interruption or delay.

HERBERT LAWS WEBB.

NEW YORK, May 21, 1892.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE annual meeting of the Institute to receive reports and for the election of officers was held at the headquarters, 12 West 31st, St. New York City, on May 17, 1892, at 4 p. m. Vice-President T. D. Lockwood in the chair. A report of the year's work ending April 30, was made by Secretary R. W. Pope. It showed a total membership of 615, namely, 3 honorary, 179 active and 433 associate. The net gain over 1890–1 was 74 members. The report of Treasurer G. M. Phelps showed a total of receipts of $6,717.48, and that the total balance in the hands of secretary and treasurer was $271.09. To this surplus may be added a special deposit of $850 now standing to the credit of building fund and drawing 2 per cent. interest. The total balance on hand to the credit of the Institute May 1, was $1,095.53. These reports were accepted.

The chairman announced that the Council that afternoon had elected to honorary membership, Lord Kelvin, Werner Siemens and Cyrus W. Field.

The officers whose names are printed in italic were then elected, those holding over being printed in roman: *President, Frank*

Julian Sprague; vice-presidents, A. E. Kennelly, Nikola Tesla, Oscar T. Crosby, T. D. Lockwood, Carl Hering, W. J. Hammer; *managers, Charles Wirt, A. S. Hibbard, Dr. M. I. Pupin, C. P. Steinmetz*, J. C. Chamberlain, P. B. Delany, H. A. Foster, H. Ward Leonard, Dr. Louis Bell, H. L. Webb, Prof. A. G. Compton, J. Hamblet; *secretary, R. W. Pope*, re-elected; *treasurer, G. M. Phelps*, re-elected.

It was voted that a committee of the Institute to report at the Chicago meeting, be appointed by the president to recommend a revised plan of election of officers of the Institute, so as to enable the whole membership to participate in the choice.

President-elect Sprague on being escorted to the chair, said that he only expressed the unanimous feeling when he asked for a vote of thanks to Mr. Lockwood for the manner in which during the year he had practically discharged all the active duties of president, on behalf of Prof. Bell. The vote of thanks was carried, all the members rising.

Mr. Sprague then appointed as the committee on revised plan of election: Dr. F. B. Herzog, chairman; Messrs. F. R. Upton and T. C. Martin.

At 6:30 p. m. about 70 members of the Institute sat down to dinner at the well-known "Arena" restaurant adjoining, and a most enjoyable evening was spent in an informal manner. Mr. Sprague presided, with Mr. Lockwood and Prof. Geo. Forbes on his right and left. During the evening speeches were made by Messrs. Sprague, Lockwood, Prof. Forbes, Mr. Oberlin Smith, past president of the American Society of Mechanical Engineers; Dr. Charles E Emery, F. L. Pope, O. T. Crosby, T. C. Martin and Dr. Louis Duncan. There is no question that the success of the dinner will make it an annual affair.

THE CANADIAN ELECTRICAL ASSOCIATION.

THE first annual meeting of this Association will be held in the city of Hamilton on Tuesday, Wednesday and Thursday, the 14th, 15th and 16th of June next. Arrangements have been completed for papers on the following subjects, and others will be announced in the official program:

"Financial Aspects of Electric Lighting in Canada," by Mr. S. J. Parker, of Owen Sound; "Long-Distance Telephony," with illustrations, by Mr. H. Neilson, of Toronto; "Safe Wiring for Electric Installations," by Mr. A. B. Smith, of Toronto; "Line Construction," by Mr. T. H. Wadland, of Hamilton; "Central Stations," by Mr. D. Thomson, of Hamilton; "Carbons," by Mr. H. O. Fisk, of Peterboro; "Steam and Electric Power," by Mr. J. J. Wright, of Toronto; "Multiple Switchboards," by Mr. J. A. Baylis, of Toronto.

The order of proceedings will be substantially as follows: Tuesday morning, executive meeting; afternoon, formal opening of the convention by the mayor and others. In the evening the members will visit the station of the Hamilton Electric Light and Power Co.

Wednesday morning and afternoon, session of Association, followed by an excursion to Burlington Beach, via steamer, and banquet there in the evening.

Thursday morning and afternoon, session, followed by a drive about the city and mountain.

The headquarters of the Association will be at the Royal Hotel, but the meetings will be held in the Board of Trade Building.

Although there will be no formal exhibition, any one wishing to exhibit apparatus will be provided with facilities in the way of current, etc.

The prospects of this Association seem very bright. At the last meeting of the executive committee, on the 10th inst., forty new members were admitted, and a growing interest is being manifested in the Association by electricians throughout the Dominion.

Reduced railroad and hotel rates have been arranged for, respecting which a circular will be sent to members in a few days. Other information can be obtained on application to the secretary, Mr. C. H. Mortimer, Toronto.

Literature.

HOUSTON'S ELECTRICAL DICTIONARY.

AN advance copy of the second edition of a dictionary of electrical words, terms and phrases, by Prof. Edwin J. Houston, has just been received from the publishers, the W. J. Johntson Co., Limited, *Times* Building, New York City. The book bears very little resemblance to the first edition which was published in 1889, and which is now so familiar to electrical readers. It is practically a new book, as it has been entirely rewritten and revised. The book is an octavo and contains 562 double-column pages printed on heavy paper. The type used is such that the titles stand out most prominently on the page. The definitions are given in two styles of type, the larger being used for the definitions proper, while the descriptive matter of a more general nature is printed in a smaller face of type. The illustrations are 570 in number and cover a very wide range of electrical apparatus. Definitions are given under about 5,000 distinct titles and nearly as many more titles are entered for the sake of giving cross-references to other titles under which their definitions can be found. The price of the book is $5.

THE WEST END RAILWAY, OF BOSTON.

AN interesting and handsome volume, with many cuts, descriptive of the development of the West End Railway, of Boston, as an electric system, has been published by Louis P. Hager, of 12 Pearl street, Boston. It is bound in cloth and the price is $1.00. Postage free.

MR. L. W. SERRELL, M. E., has contributed to the May *Engineering Magazine* an interesting article on "Electric Street Railways as Investments." It has now been reprinted in pamphlet form, and makes a very timely piece of reading for all who are interested in the subject.

Reports of Companies.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

THE annual meeting of stockholders of the Westinghouse Company was held at Pittsburgh, Wednesday, May 18. In advance of the receipt of an official copy of the report, the following figures are taken from the Pittsburgh *Leader*. The reports presented by the officers—from January 1, 1891, to March 31, 1892—showed a reduction in the company's indebtedness as follows:

	Jan. 1, 1891.	Mar. 31, 1892.	Reduction.
Bills payable	$3,076,021.11	$461,962.17	$2,614,058.94
Accounts payable	622,469 51	266,973 19	355,496 32
U. S. E. L. Co. bonds	750,000.00	650,000.00	100,000.00
Sawyer-Man Co. mortgage	210,000.00	210,000.00	———
Scrip dividend	195,962.00	194,362.00	1,600.00
Other liabilities	844,179.54	———	841,179.54
Totals	$5,198,632.16	$1,783,297.36	$3,415,334.80

There was paid for interest during the period covered by the report $135,356.64, making a total payment on account of debts and interest of $3,550,691.44. Of this sum $2,875,000.00 was provided by the sale of preferred stock, the remainder being supplied from earnings and collections. The sales from January 1, 1891, to the date of the report, including those of leased companies were $3,468,900.50.

The treasurer's balance sheet is as follows:

ASSETS.

Cash in banks	$88,145.24
Bills receivable	224,238.72
Accounts receivable	1,247,427.50
Material in stock (at cost of labor and material)	509,548 82
Advances to leased companies	1,045,057.81
Stocks and bonds	4,008,163.09
Real estate and buildings	415,092.77
Machinery and tools	459,968.86
Miscellaneous	63,424.75
Charters, franchises, patents, etc	4,816,717.19
	$12,402,769.75

LIABILITIES.

Accounts payable		$258,956.88
Bills payable		455,462.17
Scrip dividend		194,362 00
Stock subscription		85,075.00
U. S. E. Ltg. Co. 6 per cent. 15-year bonds, $50,000 payable annually		650,000.00
Capital stock liabilities:		
Preferred stock, 72,384 shares	$3,619,253.00	
Assenting stock, 100,758 shares	5,027,916.00	
Common stock, 5,526 shares	276,300 00	
In treasury, 21,832 shares		
		8,933,469.00
Surplus		1,880,445.20
		$12,402,769.75

Mr. Westinghouse presided throughout the meeting. In his report he directed attention to the impetus given the business of the company since its reorganization; the orders taken during the months of March and April last aggregating $1,576,235. The general and selling expenses had been so reduced that the company would be able to produce and market apparatus at lower prices than those prevailing last year. Over 1,600 men were employed by the company and its facilities were adequate to supply monthly sales to the amount of $500,000.

The following board of directors was elected: Charles Francis Adams, Lemuel Bannister, August Belmont, A. M. Byers, Charles Fairchild, Marcellus Hartley, George W. Hebard, Henry B. Hyde, Brayton Ives, George Westinghouse, Jr.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 10, 1892.

Alarms and Signals :—

Electric Indicator, J. W. Gibboney, 474,523. Filed Dec. 10, 1891.

Has for its object to reduce the number of circuits usually employed in electric signaling system.

Locking Device for Switch and Signal Operating Mechanism, T. H. Paternall 474,528. Filed Jan. 2, 1892.

Has for its object to prevent the possibility of changing a switch in a railway track until the train has responded to the corresponding signal.

Thermostat, A. H. Brintnell, 474,542. Filed April 11, 1891.

Designed to be very rapidly actuated to produce various kinds of alarms in accordance with the corresponding degrees of heat.

Automatic Fire Alarm, M. Martin, 474,670. Filed Feb. 21, 1887.

Electric Heat Alarm, J. Meyer, 474,673. Filed Dec. 14, 1891.

An automatic electrically operated heat regulator and fire alarm.

Conductors, Conduits, and Insulators :—

Electric Conduit, A. Bruner, 474,468. Filed March 7, 1892.

A water-tight conduit consisting of a series of pipes laid in a bed of waterproof material.

Insulating Couplings, A. Anderson, 474,569. Filed March 21, 1892.

Consists of two conducting links interlocked but separated from one another by a body of insulating material.

Connection for Electric Conductors, C. W. Tobey, 474,584. Filed Jan. 28, 1891.

A metal clip bent about the conductors and having its face provided with a coating of solder.

Distribution :—

Electrical Switchboard, L. A. Fehr, 474,632. Filed Nov. 28, 1890.

A switch pivoted in the centre of a board and adapted to connect with any one of a number of pairs of contacts placed about the board.

Dynamos and Motors:—

Dynamo Electric Machine or Motor, C. D. Jenney, 474,388. Filed Jan. 8, 1891.

Employs a frame fitted to receive and support a field magnet, the latter being secured to the frame and consisting of plates of sheet metal stamped out in the desired form and fitted within the frame.

Electric Speed Regulator, J. W. Gibboney, 474,447. Filed Sept. 26, 1891.

Claim 1 follows:

The method of maintaining a practically constant speed in a motor mechanism consisting in loading it with an electric generator and varying the effective magnetic field of said generator by changes in speed of its moving conductor

Commutator Brush, R. Hirsch & H. Meminger, 474.600. Filed Dec. 11,1891.

A commutator brush composed of a mixture of refined clay, graphite, carbonized oil or sugar, and wax covered with a metallic coating.

Circuit Controller for Electric Motors, W. S. Andrews, 474,623. Filed May 27, 1891.

Claim 4 follows:

The combination of a switch arm, a contact spring or plate at one end thereof, a contact co-operating with said spring or plate and a contact spring or plate at the opposite end of the switch arm, the latter spring bearing on a contact at each end.

Dynamo-Electric Machine or Motor, J. D. F. Andrews, 474,624. Filed Jan. 18, 1892.

Employs an armature having a ring core and two or more pairs of field magnet poles, the armature coils surrounding the core and connected together and to the commutator.

Electric Machine, H. A. Wagner & F. Schwedtmann, 474,787. Filed May 15, 1891.

Comprises a cylindrical field magnet and cap pieces forming bearings at each end for the armature shaft and completely encasing the armature.

Galvanic and Thermo-Electric Batteries :—

Exciting Fluid for Galvanic Batteries, C. Lutcke, Jr., 474,454. Filed April 17, 1890.

A concentrated solution of one or more chlorides such as copper, iron or zinc in combination with nitrate of mercury.

Heating :—

Electrically Heated Vessel, W. Mitchell, 474,398. Filed Sept. 5, 1891.

Employs an inner receptacle and an outer shell with an electrical resistance in the space between them.

Electrical Heater, W. Mitchell, 474,797. Filed Dec. 14, 1891.

Claim 1 follows:

In combination with tubular electric heater having a spider within it, a stand connected detachably to the said spider.

Lamps and Appurtenances :—

Electric Lamp Socket, W. D. Kurz & H. Amundson, 474,667. Filed Sept. 26, 1891.

A system of out-of-door decorative lighting using bare conductors.

Miscellaneous :—

Lightning Arrester, M. Dickerson, 474,469. Filed March 14 1892.

Invention consists in interposing between the discharge points a non-conducting liquid.

Ore Conveying Apparatus, T. A. Edison, 474,592. Filed Oct. 1, 1891.

Electric Wind Vane Indicator, H. J. Haight, 474,735. Filed Oct. 30, 1891.

Telethermometer, F. J. Dibble, 474,771. Filed Jan. 24, 1889.

Railways and Appliances :—

Electric Railway, Charles H. Baker, 474,355. Filed Oct. 30, 1891.

An elevated electric railway having a conduit secured to the ties between the rails.

Trolley-Wire Support, O. F. Evans, 474,375. Filed Jan. 24, 1891.

Employs the electric conducting wire as a support for the trolley wire.

Truck for Electrically Propelled Vehicles, L. Pfinget, 474,403. Filed Oct. 6, 1891.

Employs a counter-balancing device whereby a single motor may be placed at any convenient point upon a truck.

Cleaning Brush for Electric Railways, R. M. Hunter, 474,472. Filed Feb. 8, 1889.

A brush carried by a car operated by a conduit system; the brush being fitted into the conduit and carrying before it any accumulation of dirt, etc.

Trolley for Electric Railways, C. E. Friel, 474.552. Filed March 19, 1892.

Has for its object to prevent the trolley wheel from leaving the conductor at a curve or clamping on passing any irregularity in the wire.

Switches and Cut-Outs :—

Electric Snap Switch, G. K. Hutchins, 474,478. Filed Dec. 26, 1889.

Employs a base having two opposite non-conducting walls, two pairs of terminal conducting plates, a shaft centrally pivoted in the compartment thus formed, two pivoted circuit closing brushes and a separate spring acting on each brush.

Electric Switch, C. A. P. Willing and J. C. Violet, 474,541. Filed May 26, 1891.

A switch so designed that, on the closing lever being actuated, potential energy is first stored up, which, on the release of an arresting device, is transformed into kenetic energy, thus causing an instantaneous opening and closing of the circuits.

Telegraphs :—

Automatic Repeater, R. Watkins, 474,706. Filed Feb. 2, 1892.

A repeater placed in the secondary circuit and adapted to be operated from the main circuit by means of the reciprocating armature of the instrument.

PROF. HOUSTON TO LECTURE IN BROOKLYN.

PROF. E. J. HOUSTON, of Philadelphia, has consented to lecture before the Electrical Section of the Brooklyn Institute, on Wednesday, June 1, at the Young Mens' Christian Association, 502 Fulton street, Brooklyn. His subject will be, "Electricity One Hundred Years Ago and To-Day." Prof. Houston is a most interesting and instructive lecturer, and will be heard by a very large audience.

WESTERN NOTES.

THE CENTRAL ELECTRIC COMPANY report that they have secured the order through the Brush Electric Company for 82 miles Acme lead Okonite cable for the South Park commissioners of Chicago, the wire to be used in carrying current for the lighting of the boulevards to the World's Fair Grounds; Okonite being selected because of its high quality, and being able to conform to the stringent guarantees required.

MR. EUGENE A. ERICH, the Western agent of the Waddell-Entz Electric Co. has removed his offices from the Rookery to suite 1437-1438 Unity Building on Dearborn street, Chicago. The offices overlook the lake and will be handsomely fitted up, and several of the Waddell-Entz dynamos and motors swill be placed on exhibition.

L. K. COMSTOCK and W. D. BALL, both well-known consulting and contracting electrical engineers of Chicago, who have occupied an office together at No. 427 Rookery for some time past have removed to larger and handsomer quarters at room 419 Monadnock Building, where they will be glad to receive a call from their many friends.

THE BRUSH ELECTRIC CO. have removed their Chicago offices from 225 Dearborn street to the large and beautiful office building, the "Monadnock," corner of Dearborn and Jackson streets, where they have secured a suite of seven rooms extending across the entire front of the building on the post office side.

MR. FRANK B. RAE, the electrical engineer of Detroit, Mich., has been driven by the increase of professional work to take larger quarters, and has now moved into offices at 27 and 28 Cleland Building, 31st street, Detroit. Mr. Rae continues to make electric railroading and power transmission his specialty.

MR. WILLIAM H. MCKINLOCK, the founder and president of the Southern Electrical Supply Company, has just returned from St. Louis, and reports the Southern as doing a very brisk business, and says that under the new management, the prospects for enlarged future trade are very encouraging.

MR. CHARLES E. SHARP has been appointed manager of the Southern Electrical Supply Company. Mr. Sharp is a conscientious, pains-taking business man, and since his appointment (May 1) has gotten back a good many of the old customers of the Southern, besides new ones.

THE JENNEY ELECTRIC MOTOR COMPANY, of Indianapolis, have recently purchased a large amount of new machinery and heavy tools and now have very extensive equipments to handle the largest class of electrical generating machinery.

THE CENTRAL ELECTRIC COMPANY report a very active business in the Interior Conduit and Insulation Company specialties, a great many of the large buildings being equipped with this conduit in Chicago and elsewhere.

PROMINENT among the new apartment buildings in Chicago are the Erie, Mecca and the Groveland. All three of these are fitted with electric lights, the wire being supplied by George Cutter.

MR. E. ATKINSON, formerly connected with the Edison Laboratory at Orange, N. J., in charge of mechanical work, has accepted a position with the Standard Oil Company as salesman.

THE SUNBEAM INCANDESCENT LAMP COMPANY are the recipients of some highly flattering testimonials regarding their incandescent lamps.

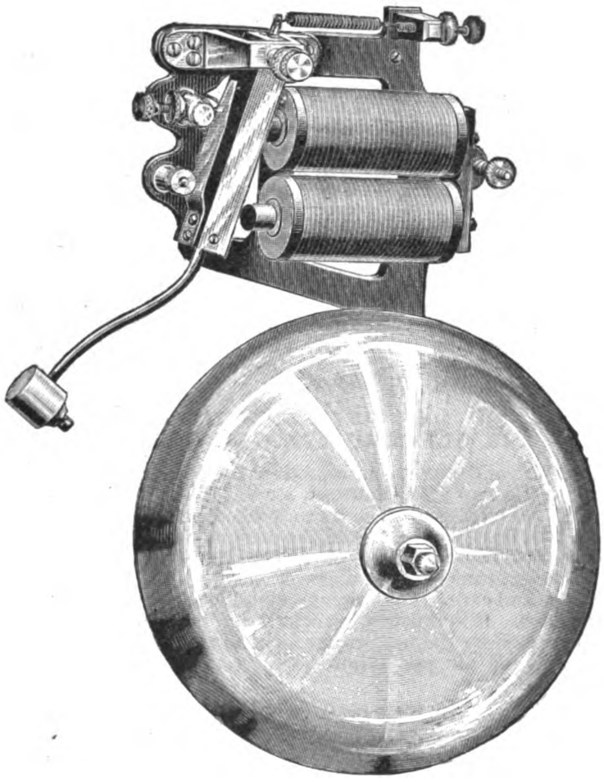
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

All successful advertising is cumulative in its effect and results.

THE "NOVELTY" PATENT HEAVY STROKE ELECTRIC BELL.

THE NOVELTY ELECTRIC Co., of Philadelphia, have recently brought out a new patented heavy stroke bell which has many new points of merit and is the invention of their ingenious superintendent, Mr. C. J. Miller. The bell has a large gong and is intended for fire-alarm and railway work where a loud and distinct stroke is desired. The principal feature of this bell is its long, movable magnetic circuit. The projecting cores into the holes in the armature give it a remarkably long stroke and quick action. The armature is in the same relative position to the cores at a greater, as it is at a lesser distance, and gives its final hard stroke when brought up to the main body of the core. The battery power required, size of magnets, and length of wire, remain the same as in bells of older type. The change from the old style of bell to the new with projected cores and corresponding holes in the armature permits a heavy stroke of 45 degrees on the gong. The main body of the core is made heavier than the projected ends, so as to present a still larger surface to the armature when brought into immediate proximity to them, which gives a powerful blow at the end. The bell is reliable in its action. It does away with many defects usually found in electro-mechanical gongs, also with the clock movement, doing away with the necessity of winding. All parts are made interchangeable and are furnished with damp-proof magnets, etc., when wanted for outside work. This bell has been adopted by the Pennsylvania Railroad Company. They have several of large size now in use for railroad signal and other heavy work.



"NOVELTY" HEAVY STROKE BELL.

ROYAL ELECTRIC CO., OF MONTREAL.

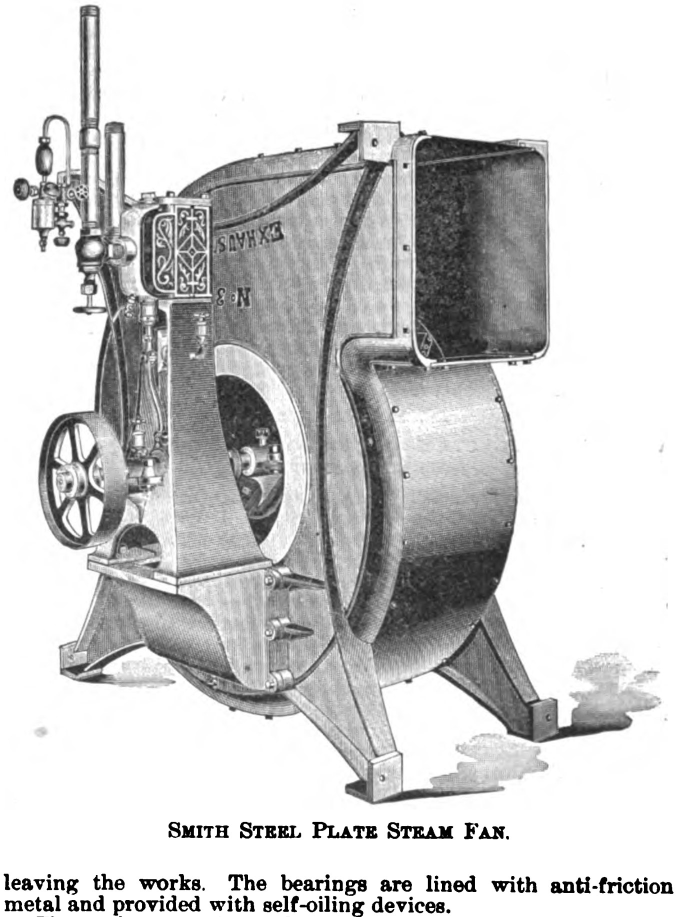
THE ROYAL ELECTRIC COMPANY, of Montreal, Canada, has secured the necessary authorization of the Canadian Government for its extensive scheme for the utilization of the water-power at the Chambly Rapids of the Richelieu River, the outlet of Lake Champlain. Operations will be conducted by its sub-company, the Chambly Manufacturing Company, as the Royal Electric Company is not permitted by its act of incorporation to engage in such enterprises; 25,000 h. p. will be available at low water, and plans are now being elaborated for its conversion into electricity and transmission to Montreal, 18 miles distant, to be utilized there for light and power. A series of dams is to be built across the river, upon which work will be commenced as soon as the water is low enough. Arrangements have already been made for line and other materials, and operations will be pushed vigorously so as to utilize a portion of the water-power as soon as possible.

Before deciding upon this project, the Royal Electric Company had separate examinations made of these rapids and those of the St. Lawrence River at Lachine, by eminent American and Canadian engineers. Though the American engineers consulted reported favorably upon the Lachine Rapids, the company, in selecting the water-power of the Chambly Rapids for development, were guided by the advice of the best Canadian engineers, who, it is to be supposed, understood better the conditions due to the peculiarities of the Canadian climate. Their report was that the formation of anchor ice and the backing up of the water would render the utilization of the Lachine Rapids impossible in winter.

As an example of the difficulties encountered, it may be mentioned that one channel in the Lachine Rapids at times gets blocked up with ice and is frozen in a solid mass down to the very bottom of the river.

THE SMITH STEEL PLATE STEAM FAN.

THE accompanying illustration shows a combination fan and engine built by the Huyett & Smith Manufacturing Company, of Detroit. The arrangement, as will be seen, is exceedingly compact. The engine is bolted directly to the frame of the fan, which is made of heavy angle iron and sheet steel with T and angle beams, the foundation being one solid cast plate. The fans are usually made for exhaust with the inlet on the opposite side from the engine, but where required for blowers, an opening appears on each side. They are built with the engine on either side, or are furnished alone if desired. The wheels and fan shaft are of steel, the former being accurately balanced and tested before leaving the works. The bearings are lined with anti-friction metal and provided with self-oiling devices.

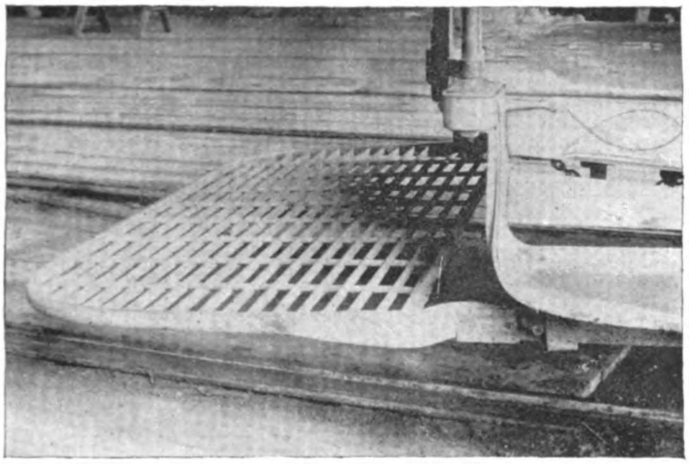


SMITH STEEL PLATE STEAM FAN.

The engines are of neat design and finish, specially constructed for this purpose with balanced piston valves, counterbalanced reciprocating parts, large bearings, perfect lubricating devices including sight feed lubricator, and are claimed to be durable and economical in operation.

THE JOHNSON "LIFE GUARD."

The secular press of some our country towns, and even of our larger cities is never happier than when discoursing upon the "Juggernaut" and describing the shrieks of the public as the "deadly electric car," gathers it in beneath its wheels. The unfortunates who perish through the agency of steam or cable traction are rarely eulogized to any great extent. As a matter of fact, if a man, or, indeed a woman or child will step in front of a rapidly moving car of any kind, an accident is apt to occur, and in such cases some of the guards in general use have proved of very little benefit to the victim. It is said by experts that the discomfort of being tumbled and shoved along over a rough road-bed by a wheel-guard is nearly as great as being run over by the wheel, and the ordinary form of "cow-catcher" is a most inhospitable arrangement, designed merely to get rid of an incumbent in the shortest possible time and without regard to his finer feelings.



The Johnson "Life Guard."

A totally different idea is embodied in the "Johnson" life guard, invented by Mr. T. L. Johnson, of Cleveland, Ohio, and in successful operation upon the Brooklyn Street Railroad Company's lines in that city. Its action will be seen at a glance from the accompanying illustration. Instead of allowing a pedestrian to be thrown aside in the way of other vehicles or beneath the body of the car to take his chances with the wheel guard, this device merely throws his feet from under him and carries him safely until the car can be stopped, thus avoiding any greater injury than a bruise or sprain. The forward edge of the guard is rounded and padded and has a strong, but yielding surface. It is attached to the car by means of brackets under the steps, may be readily and quickly applied, and since its usefulness has been thoroughly demonstrated is being extensively adopted. We have seen statements of a number of interesting cases in which it has proved thoroughly successful.

A COMPLETE ELECTRIC SYSTEM FOR THE DETROIT CITIZENS' STREET RAILWAY CO.

After carefully investigating the merits of all the leading electric railway systems, the Citizens' Street Railway Company, of this city, awarded the Detroit Electrical Works the entire contract for the equipping of their Jefferson avenue line with electricity. The contract includes the entire power station plant, overhead lines and motor equipments, as follows: The power station steam plant is to consist of three horizontal return tubular boilers 66 inches in diameter, 16 feet long, each to have sixty 4-inch flues; and three 14–24 x 14 Westinghouse automatic compound engines, with all necessary apparatus, such as feed-water heater, pump, injectors, piping, smokestack, etc.

The power station electric plant is to consist of three 100 K. W. multipolar railway generators of the Detroit Electrical Works, latest type. Also, slate switchboard of the latest and most improved design, with all instruments and attachments necessary to make a complete electric plant.

The overhead construction will consist of two No. 0 B. & S. gauge hard-drawn copper trolley wires, with necessary feeders and guard wires, supported on Milliken iron poles. The standard to be used for that portion of the avenue which is 70 feet wide from curb to curb, and their extra heavy type where the avenue is 80 feet from curb to curb.

The motor equipment will consist of twelve 40 h. p. motor equipments of the Detroit Electrical Works standard type.

If the work is not delayed by injunctions or obstructive measures of that character, it is expected that the plant will be in operation in about 75 days. As this will be the first line running through the centre of the city of Detroit to be equipped with electricity, the plant is to be made a model one in every respect, to which end the Detroit Electrical Works are making provision for building it on the most improved lines, and including all of the latest appliances.

As this contract is only one of a number that have lately been awarded the Detroit Electrical Works in face of sharp competition by manufacturers of other electric railway apparatus, it shows plainly that this company is fully substantiating their claims, that their equipments, using one motor geared to both axles, have great advantages. The extensions to the factory of the Detroit Works are now nearing completion, and they expect soon to have it equipped and in operation, when they will undoubtedly be in better position to push the business as its growth requires.

THE LUNKENHEIMER BRASS MANUFACTURING COMPANY.

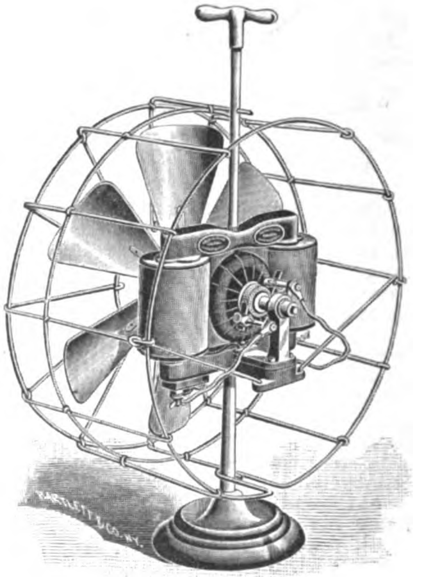
A very ornamental catalogue for 1892 has just been issued by the Lunkenheimer Brass Manufacturing Company, of Cincinnati, Ohio, giving detailed descriptions of the various brass and iron goods and specialties for steam, water, gas, oil, etc., made at their works. The book contains 98 pages, is handsomely printed and bound, and profusely illustrated with excellent wood cuts. The aim of the compiler has been to make the work plain, practical and compact, in addition to which he has succeeded in making it highly attractive.

THE BUCARAMANGA PLANT.

In our issue of May 11 we inadvertently stated in the description of the electric light plant at Bucaramanga, U. S. of Colombia, that the plant had been installed by Mr. Julio Jones, for the Thomson-Houston International Electric Company. The fact is that Mr. Jones not only installed the plant on his own account, but is owner of the entire property. The enterprise is the more creditable and noteworthy.

THE ELECTRO-DYNAMIC CO.'S FANS.

The fan and motor combination introduced by the Electro-Dynamic Co., of 224 Chestnut street, Philadelphia, is simple, durable and effective. The motor embodies all the latest improvements that have been made in the designs of the company's larger machines; is fitted with self-oiling bearings, has a tempered copper commutator, runs with no appreciable noise and requires but little attention and care. The fan is twelve inches in diameter and has four blades. It is finished in nickel or polished brass, as desired; and, operated by the motor, has a capacity of moving about 1,000 cubic feet of air per minute, which gives it ample capacity to ventilate an apartment of ordinary size. The record for this fan is 5,000 hours, running without injury to bearings and with no expense beyond one renewal of the brushes, and turning off the commutator on one occasion.



The Electro-Dynamic Co's Fan Outfit.

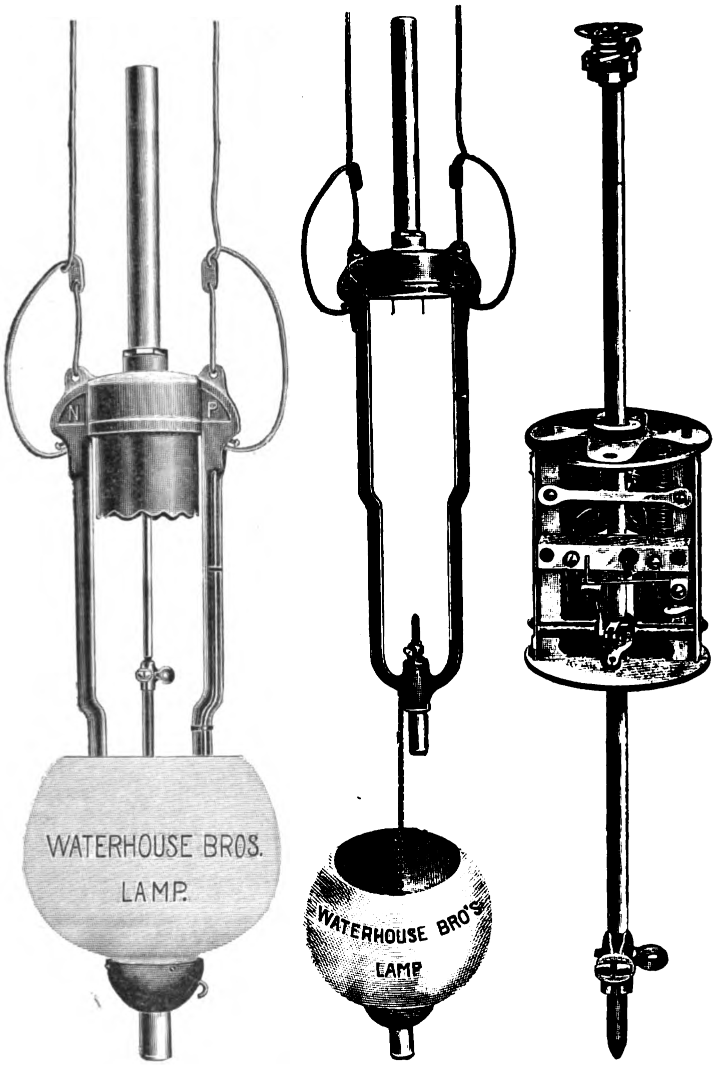
The Electro-Dynamic Company manufacture a fan having two blades, with a capacity to move about 600 cubic feet of air per minute, which has received particular commendation as a desk fan for use in offices during the heated summer months, and also small motors for running sewing machines, watch makers' lathes and similar small apparatus.

THE DETROIT ELECTRICAL WORKS.

A recent issue of the *Detroit Evening News* contains an interesting article on the above institution, which was started in 1879 and now has a capital stock of $2,000,000 of which $1,000,000 has been issued. The old factory of three stories, 150 by 120 feet, is being supplemented by another also three stories, 100 by 120 feet. The steam plant aggregates 500 h. p., 220 hands are employed and the output last year reached $750,000. The electric railway system is now in use on 29 railroads, and contracts have lately been closed for other roads at Newark, N. J.; Brooklyn, N. Y.; Cleveland, O.; Springfield, Ill.; Chicago; Kansas City; Dubuque, Ia.; Omaha and Galveston. The works are also building a large quantity of electric power apparatus, motors and general electrical apparatus. The officers are Hugh McMillan, president; W. A. Jackson, vice-president; W. H. Wells, secretary, and Louis Warfield, general manager and treasurer.

WATERHOUSE BROS'. ARC LAMP, FOR ARC OR INCANDESCENT CIRCUITS.

WATERHOUSE BROS., of Hartford, Conn., are now manufacturing what might practically be called a universal arc lamp. The lamp is manufactured, and can be sold, in two separate parts—the frame and works as shown in Figs. 1, 2 and 3. The same frame and carbon rod is used for any kind of current, while the works, as shown in Fig. 4, for incandescent, differ slightly from those for arc circuits, but all fit the same frame. All parts are made entirely by machinery, without the aid of hand tools, thereby insuring exact duplicates and interchangeability. By uniting all the working parts of these lamps in a cage constructed of a single casting, shown by Fig. 4, an exact adjustment of the parts is secured; and they are rigidly held in their places. This enables the manufacturers to produce lamps so that their action will be exactly alike, strong and perfect, and gives the operator a lamp that can be quickly and inexpensively repaired or changed from one circuit or candle power to another without removing the frame from its hanging position and without the aid of skilled labor.



FIGS. 1, 2 AND 3.—WATERHOUSE ARC LAMP.

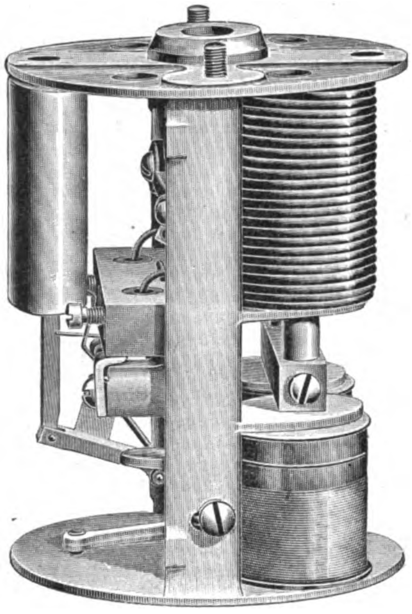


FIG. 4.—WATERHOUSE ARC LAMP.

There is but one insulating washer in or about the lamp, the top of the frame being filled with an insulating cement in which go the terminals and anchor plate to which the works, as shown in Fig. 3, are fastened by two bolts, while the lower carbon holder is held in position by cement also. The lamp is weatherproof and requires no hood when exposed to the elements. The globe holder is of cup-shape and dust-tight for inside use, so no sparks can fall from the lamp, and it is properly drained for outside use. It is made to swing down from the lamp so that it and the globe can be easily tipped and cleaned without unfastening the screws.

The advantages of the clutch form of lamp have been retained, and by a peculiar device on the top of the carbon rod, the drop or overfeeding, is avoided. This feature is particularly noticeable when the lamps are burning on incandescent circuits; the feed being so fine and positive, that the see-saw effect, so often objected to, is entirely overcome, giving a steady and even light from both lamps in series.

NEW YORK NOTES.

MR. W. F. D. CRANE, who has been widely and favorably known as manager of the railway department of the Engineering Equipment Co., has recently become connected with the H. W. Johns Manufacturing Co., 87 Maiden Lane, New York, and will hereafter have charge of the electrical department of that company. Announcement has been made of the consolidation of the moulded mica insulating business of the Gould & Watson Co., of Boston, with the Johns-Pratt Co., of Hartford. Mica trolley line insulating materials have entered into the construction of numerous electric railways since the beginning of electric railway enterprises, and are so well known as to have become standards of use in overhead construction. The Vulcabeston insulating material, manufactured by the Johns-Pratt Co., is also well known to makers and users of electrical machinery. Mr. Crane will give his special attention to the further development of the already large business of the H. W. Johns Manufacturing Co., selling agents of these materials.

J. G. WHITE & Co. report their construction business prosperous, and say they have seven electric railway contracts on hand mostly with iron pole construction. Among those recently closed are 7½ miles for the Baltimore Traction Company, 16 miles for the New Orleans and Carrollton Railroad, and 11 miles for the Central Railroad Company of Baltimore.

MR. CHARLES F. G. KOPSCH, electrical engineer of Sidney, N. S. W., is on a visit to this country, and has been in New York en route for San Francisco. He has been spending considerable time in Europe, and will represent various firms on his return home.

MR. LUTHER STIERINGER has just returned from a Southern trip of recreation, and now proposes to hie away to the wilds of Minnesota, in order to ascertain whether he would rather spend his time and fortune in the far North than down South.

VULCA DUCTS.—Considerable interest in local lighting circles was created last week by the statement that the Interior Conduit & Insulation Co. had brought suit against the Eureka Electric Co for infringement of its patents in putting conduits into the fine new Seabury Building on Maiden Lane. It appears that the Eureka Co. have the electrical contract for the building, and have used the Vulca duct made by the New York Insulated Wire Co. Inquiry into the subject elicited the fact that the New York Insulated Wire Co. had at once stepped forward and assumed all the responsibilities of the case. In an interview on this subject last week, Mr. J. W. Godfrey, the manager of the New York Insulated Wire Co., said: "We no sooner heard of this action on the part of the Interior Co., than we took up the gauntlet. In fact, after so many threats, they would have looked very ridiculous if they had not gone for somebody; and I don't think they have improved the matter by attacking an entirely disinterested third party who only bought what he knew to be the best in the market. I would like to say for the information of the public and the guidance of our many friends all over the country, that we are going right ahead, and that while we have not sought this litigation, we are advised by the best legal and patent talent in the country that in nowise do we infringe. The idea of running wires through tubes is a very old one, and except that, our material, processes and methods are all our own, worked out with great skill and already tested by experience in all kinds of work. We will protect all who use our Vulca ducts just as completely as those ducts protect their wires for them; and I need hardly say that our company has the entire confidence of the electrical trade, won through several years of upright dealing. The truth of the matter is that our ducts are by long odds the best. If they were not, the others would control the field; but as we have got to the top by merit, it is now sought to damage our prospects by this kind of intimidating litigation. But that dodge won't work in such an intelligent community as ours."

THE DETROIT ELECTRICAL WORKS have been compelled by the active demand in the East for their railway, power and general electrical apparatus, to open a New York office. It has been located at rooms 11 and 311 Metropolitan Telephone Building, 18 Cortlandt street. It will be in charge of Mr. T. W. Warfield as district manager. The works have also opened an office in Boston at room No. 23 Fiske Building. The many patrons and friends of the concern in the East will greatly appreciate the convenience of these new offices, and the works will also be put in much closer touch with the large market that exists east of Detroit for the excellent products of the works, to any demand for which the increased facilities will now prove equal.

THE NEW YORK ELECTRICAL WORKS, 161 Washington street, New York, are now settled in a thoroughly equipped factory for the manufacture of general electrical specialties. Some ingenious and simply constructed quick-breaking double and single pole switches are among the devices made by this company. They are also sole makers of the celebrated B. & M. trolley wheels. These wheels are made of a metal which is a special "bronze," of a bright silvery color, very tough, and which does not tarnish. Wheels made of this metal have a record of 10,000 miles with very little perceptible wear. The company make a special offer, that upon the return of worn-out wheels they will allow 20 cents per lb. for the old metal.

"IT WAS NECESSARY—for us to move into more desirable and larger quarters" is the reason given by J. Jones & Son, who are now located conveniently on the second floor at 39 Vesey street. This company have of late been doing such an amount of special work for large companies located in the downtown district, that after due deliberation it was decided for the convenience of both manufacturers and patrons to make the above change. The intention is to carry a complete stock of supplies, and continue as well the making of electric light and railway supplies.

THE CHILLICOTHE, O., ELECTRIC RAILWAY & LIGHTING CO. has just been organized by Geo. F. Woolston and associates, of New York. The company will erect an arc and incandescent light station. They have also bought out the horse railroad company and will at once convert to electricity beginning with a 10-car equipment. Power will be furnished from the lighting station.

THE THOMSON-VANDEPOELE MINING COMPANY, of Boston, have recently sold to the Boston and Montana Mining Company three M. P. 180 h. p. generators for use in its electrolytic plant at Great Falls, N. H. The plant will be similar to the Lewissohn plant at Pawtucket, R. I., and construction will be proceeded with at once.

MR. W. R. MASON, the ubiquitous and very active genera manager of the Railway Equipment Co. was in the city last week, making agencies and securing them for his own territory. For the present business will be carried on at 11 Adams street, Chicago.

THE MICA ASBETITE COMPANY, 444 Pearl street, this city, are in receipt of several handsome orders for their railway specialties from different points in the West where electric railways are in course of construction.

THE JOSEPH DIXON CRUCIBLE CO., of Jersey City, have just issued a new and useful catalogue, including graphites, plumbago, etc., now so largely used in the electric arts.

NEW ENGLAND NOTES.

THE EDDY ELECTRIC MANUFACTURING COMPANY, of Windsor, Conn., are making rapid progress with their new extension and expect to occupy it some time in July. The new wing measures 154 feet long by 50 feet wide, and will have three stories. A large new tubular boiler has been put in, and a 150 h. p. Ball & Wood engine will be installed very soon, which will be chiefly used for testing purposes. The Eddy Company have been extremely busy lately, and have been forced to run 24 hours a day. Their business this year is just about 50 per cent. ahead of what it was in 1891, and the increased facilities when ready will be very welcome to the management. They are at present building four 250 h p. generators for furnishing power for the Manufactures and Liberal Arts and sundry buildings for the World's Fair, for which they received the contract some months ago. They are also building two 100-kilowatt railway generators for the electric railway at Atlanta, Ga., and two 100-kilowatt railway generators for the West End road in Rockford, Ill. Altogether, their factory presents a busy scene, and their business prospects never looked brighter than at present.

THE EASTERN ELECTRIC SUPPLY AND CONSTRUCTION COMPANY have for some time, owing to their largely increasing business, been looking for more commodious quarters, and have at last decided to move to 77 Franklin street, and 80 Arch street, Boston, where they will have much more room to transact their business. Their new quarters are well known as having previously been occupied by the Pope Manufacturing Company, and are most centrally situated and extremely convenient. They will occupy the whole ground floor and basement, will have about 8,000 square feet of floor space, and expect to get settled about June 1st.

THE EASTERN ELECTRIC LIGHT AND STORAGE BATTERY COMPANY, of Lowell, Mass., have secured the contract for the complete electric equipment of the buildings of the new Rotch Spinning Corporation of New Bedford, Mass., and also a 100-light storage battery equipment for the Cambridge House of Correction, Cambridge, Mass. They are also equipping the new offices, stores and waiting-room of the Lowell and Suburban Street Railway Company with storage batteries, which will be charged from the trolley wires.

ALBERT & J. M. ANDERSON, of Boston, have appointed Mr. Robert W. Blackwell, 39 Victoria Street, Westminster, London, as their agent in England. Mr. Blackwell will keep in his office a complete line of samples of the well-known Boston trolley, and all kinds of the Ætna insulated trolley line material, and will be glad to show them to all interested in the development of electric railways in England and other European countries.

MR. E. W. FYLER has resigned his position with the Holtzer-Cabot Electric Company, of Boston, and has gone into business for himself with headquarters in the basement of the Exchange Building, Boston. Besides doing a general electric construction business, Mr. Fyler has taken the agency for the International typewriter, and will be glad to have a call from his friends at his new quarters.

THE ENTERPRISE ELECTRIC COMPANY.

MR. W. C. MCKINLOCK, formerly with the Central Electric Company, of Chicago, and later manager of the Southern Electric Supply Company, of St. Louis, for which company he built up a very large and successful business, has resigned and organized the Enterprise Electric Company, which will deal in general electrical supplies of all kinds for telegraph, telephone, electric light and power work with a handsome store and offices at No. 313-315 Dearborn street, Chicago. Mr. McKinlock has a host of friends in the electrical business, and is well known for his push, ability and energetic business qualities and the success of the new company is a foregone conclusion from the start.

A number of very valuable specialties have already been secured and the concern will be the local agents for Kerite wire, for which Mr. W. F. Cushing is the general Western agent, and will also handle a line of goods manufactured by the Western Electric Company, of this city, as well as other valuable specialties. An exceedingly large stock in all branches will be carried enabling prompt shipments.

Mr. F. P. Hill, late of the Southern Electric Company, of St. Louis, and Mr. W. F. Richardson, formerly of the Central Electric Company, of Chicago, are connected with Mr. McKinlock in the new venture, and it is probable that Mr. Hill will be the secretary of the company. The promoters of the new supply house are all bright men, familiar with the business in all its branches and with a large circle of friends in the electrical field in all parts of the country form an exceedingly strong personnel which will insure a large amount of business being done from the outset.

☞ *Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.*

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THE UTILIZATION OF EXHAUST STEAM FOR HEATING BY THE SPRINGFIELD, ILL., ELECTRIC LIGHT & POWER COMPANY'S PLANT.

BY

H. Dorman Collins.

SPRINGFIELD, Ill., offers to-day a very interesting exemplification of high economy in central station operation, and I venture on a description of the plant I have recently seen there. Anything which tends to increase the dividend and bring about more economical operation will be eagerly welcomed by the central station man, who is usually very much on the alert to enlarge the productiveness of his plant.

In the early days of central stations only lights were operated and these called generally for the running of the plant only at night; but with the advent of the electric motor for power work came the opportunity of more continuous working of the plant and largely increasing the earnings as the machinery performed more hours of service, bringing in a larger amount of money upon the investment. It is therefore not to be wondered at that a method of utilizing the exhaust steam and turning into money that which has formerly gone to waste should be attracting the attention of those engaged in central station work and receiving the introduction and adoption it deserves, when it is remembered that by this means many a station whose returns are exceedingly slim, or none at all, can be rendered profitable. Such a plan, complete in every particular and worked out to its minutest detail, is the "Holly Combination System" for the utilization of the waste steam of central station plants, which is manufactured by the American District Steam Company, of Lockport, N. Y. This system was described in a recent number of THE ELECTRICAL ENGINEER.

With keen foresight the officers of the Springfield Electric Light & Power Co., of Springfield, Ill., recognizing the advantages of realizing on the exhaust product of their station, and after a careful investigation of the system, decided to add it to their plant, and the results have shown the wisdom of their course and the stockholders have no reason to regret their action, which has proved more successful than their most sanguine anticipations.

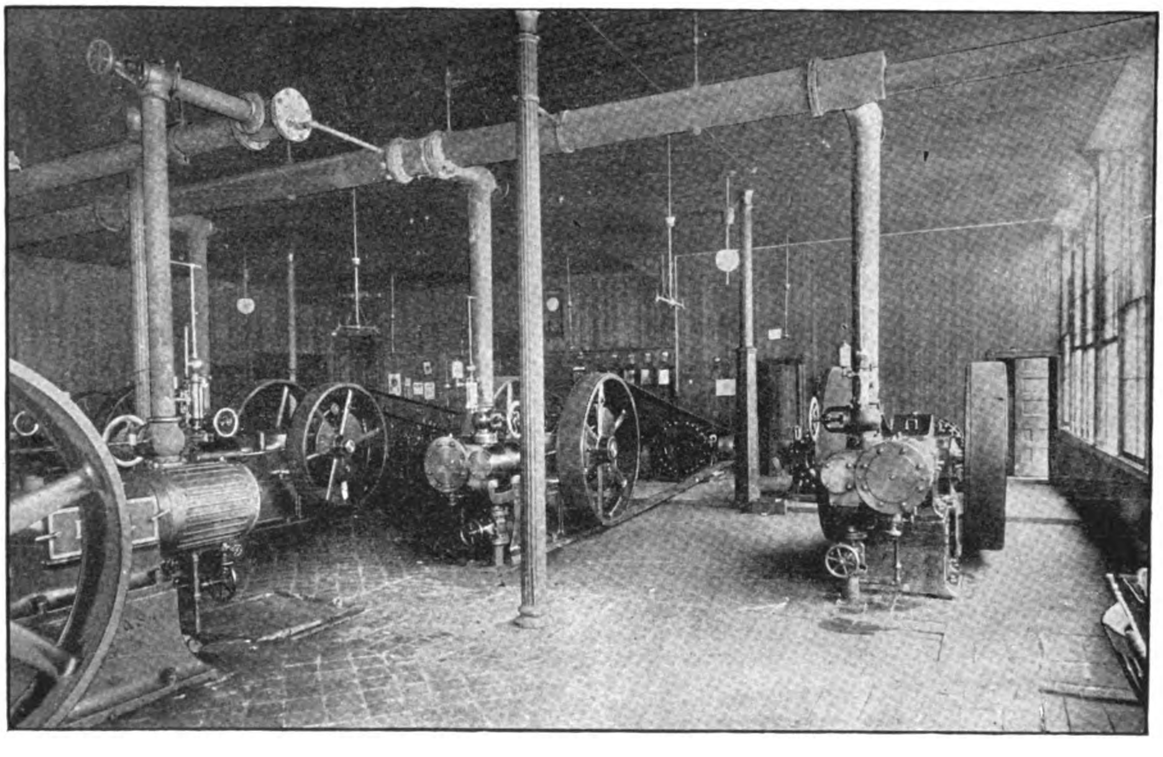


FIG. 1.—ENGINE AND DYNAMO ROOM, SPRINGFIELD, ILL., ELECTRIC LIGHT AND POWER CO.

The accompanying illustrations Figs. 1, 2 and 3, show this plant very clearly. It comprises six 50-light Thomson-Houston arc machines, belted direct to Ideal engines of 125 h. p. each, made by the well-known engine builders, A. L. Ide & Son, of Springfield, Ill. In connection with the arc lighting machines an exceedingly novel arrangement for keeping the armatures cool is employed. A small 2 h. p. motor runs a Sturtevant blower located beneath the floor, which forces air through a 10-inch main and 4-inch supply pipes upon the armature of each machine. This method of ventilation has been found to be highly satisfactory, and the fact that an armature has never been lost from any cause, speaks highly for the efficiency of the treatment. The dynamos connect with a switchboard so arranged that any dynamo can be placed on any desired circuit. The incandescent portion of the plant consists of one 650-light Thomson-Houston alternating current machine and one 1,300-light machine of the same make and style. These machines are connected to a handsome switchboard equipped with all necessary switches, instruments, etc., and are also driven by Ideal engines; 150 arc lamps of 2,000 c. p. capacity each and 250 incandescent lamps of 20 and 50 c. p. are run for street lighting by this plant, which also furnishes current for some 75 commercial arc lamps, and on special occasions for from 25 to 50 more arc lamps and incandescent lamps equivalent to the capacity of the alternating dynamos. In addition a motor circuit is in operation, current being supplied by a 50 h. p. generator to run some 25 motors of capacity varying from ⅛ to 10 h. p., three of which are running elevators.

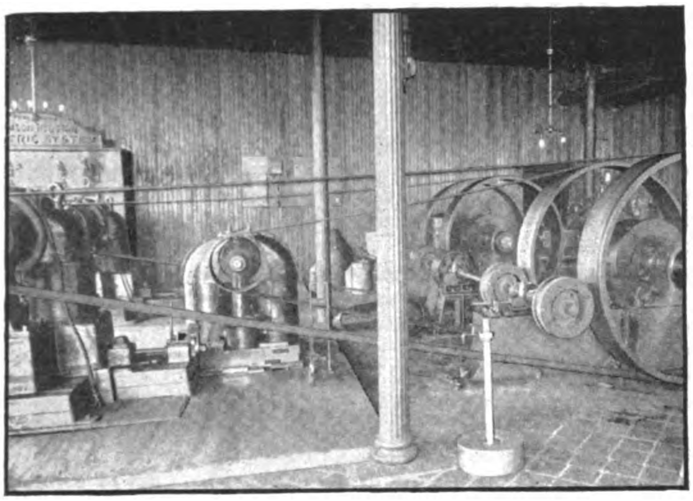


FIG. 2.—SPRINGFIELD, ILL., ELECTRIC LIGHT STATION.

The power plant for furnishing current for the street railway is operated by the station and consists of three 100 h. p. Thomson-Houston railway generators driven by three 125 h. p. Ideal engines, belted direct. A very ingenious friction drive has recently been installed to enable either one or two of these engines to drive the generator, furnishing current for the motor circuit. This is shown in Fig. 2.

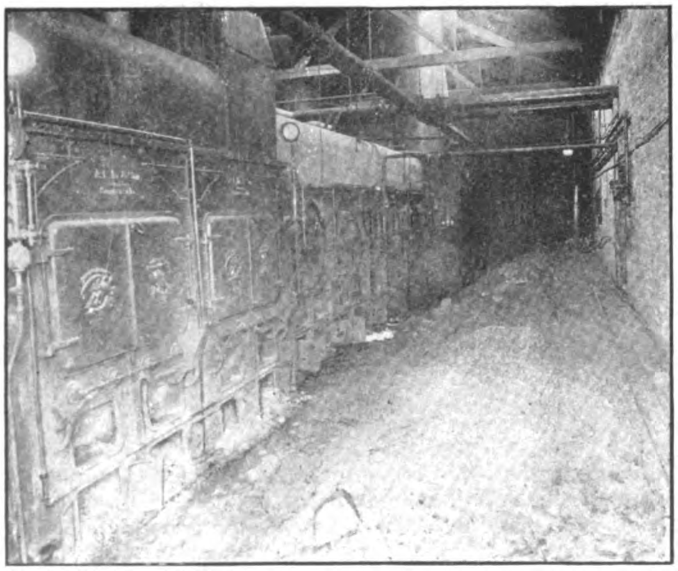


FIG. 3.—SPRINGFIELD, ILL., BOILER ROOM.

In the boiler-room are nine boilers manufactured also by A. L. Ide & Son, two of which are of 100 h. p. capacity each; three of 80 h. p. each and the remaining four of 60 h. p. respectively, and which furnish steam for the engines.

The lightning arresters which were formerly placed in the top of the tower from which are distributed the circuits, have recently been changed and lowered in the tower to a level with the ceiling of the dynamo-room. Pipes run so that in case of an arc from lightning they can be surrounded with live steam. This precaution was taken from experience gained from a recent storm when an arc formed by the coming in of the lightning upon the arresters almost resulted in a disastrous fire.

The exhausts of the engines are connected to the mains of the steam heating plant, Fig. 4, which are 8 inches in diameter and which shortly after leaving the station branch into smaller mains, 6 inches in diameter. This exhaust steam is being furnished for heating to about 16 business blocks, and not the least difficulty has been found in securing in the immediate vicinity of the station all the business in this line that can possibly be taken care of.

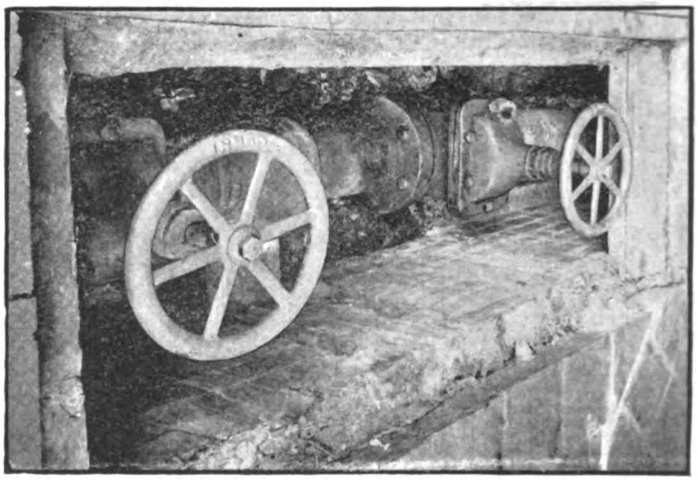


FIG. 4.—CONNECTION OF EXHAUST WITH STREET STEAM MAINS.

Ordinary radiators are employed and something over 2,000,000 cubic feet of air space in these buildings is now being heated, and this will be increased to over 3,000,000. The amount of power of exhaust steam at present in service at a pressure of about 5 lbs. is 200 h. p. At first contracts for steam heating were taken by the company at a price of $2.50 per 1,000 cubic feet of air space per year, but they are now based, and more properly so, upon a charge of 20 cents per foot of direct radiation per year, or 25 cents on indirect radiation. The use of this system, while yielding a most generous profit to the station, is also cheaper for the consumer, as he can dispense with the services of an engineer or janitor to look after his boiler and steam heating apparatus whom he has to employ when operating his own steam heating plant; and from the fact of steam being on day and night it has been demonstrated that 25 per cent. less heating surface is required than where the heating is done by boilers in the buildings; in many cases this percentage of radiating surface has been taken out on account of the heat being greater than required. An average estimate for the amount of heating surface required is one square foot of radiation to 50 cubic feet of air. At the station an automatic device is provided to prevent the pressure exceeding 5 lbs. and the 5 lbs. back pressure on the engines is compensated for by an additional 5 lbs. pressure on the boilers. The limitation of area of supply for the highest economy in operation in any territory which is well built up is estimated as about half a mile, but even buildings at considerably greater distances can be supplied with good results. It is also perfectly safe to take on at least one-third more customers than the total number which the exhaust steam of the station is capable of supplying, as, if necessary through the most severe weather when the demand is at its greatest, a small amount of live steam from the boilers can be conveniently supplied, arrangement being made in the system for such a contingency.

The additional amount of fuel required during the time of heating does not exceed 5 per cent. The investment upon the installation of the steam heating system is very reasonable, and wear and tear on the pipe junctions, connections, etc., is practically nothing, as they will last for years and repairs will be very low. The receipts from the heating are practically all profit in the case of a plant operating both day and night, where a portion of the engines are running all the while driving dynamos, furnishing light and power.

Not only are the central station men enthusiastic over the success of the system which they regard as the best-paying investment in the business, the profits being at least double that from light or power, but the consumers are equally delighted with the excellence and absolute reliability of the service, and it is safe to predict that the time is at hand when the system will receive the full consideration and use that its merits and advantages entitle it to.

The day is not far distant either when the householder will be able to buy his heating from the central station in his vicinity as he now does his electric light, water or gas, and will no longer struggle in frigid desperation with the malignant hot-air furnace, which, just when the cold snap comes along, evinces a persistent disposition to force the hot air into the cold-air shaft instead of the room, and shifts its scene of operation with every change in the wind, and he will once more think that life is really worth living.

THE ECONOMY OF CONDENSING ENGINES OVER-RATED.

BY

D H Babcock

It is safe to say that electricity in its varied developments has absorbed more capital in the brief space of a few years, than any other element or enterprise has ever before done in the same space of time, since man first broke into nature's storehouse. It is for this reason that the best scientific minds are enlisted in the cause. The best engineering is demanded. Discussion and experience are settling doubtful points, and are constantly making new discoveries in the field of economical application of known results. All this wonderful activity is in obedience to the demands of capital. Capital commands the best service obtainable, whether on sea or on land, whether on the earth in the light of day, or in the deepest mines where night reigns perpetual. And why is capital thus exacting? It knows well that thrift comes from enterprise, activity, invention. Capital undertakes great enterprises for the profits believed to be in them. It makes investments from which better interest is expected than the banks are able to pay. For this reason capital has invested in these electrical enterprises, and if they are not made to pay it will know the reason why. While the field is a hopeful one and success has been achieved at some points where the most favorable conditions exist, yet there is need of "the highest grade of engineering supplemented by close business management" all along the line. Good engineering may construct a plant perfect in all details but loose business management may also conduct the enterprise to a failure.

In a previous paper I showed that some companies are deriving a large profit from their *exhaust steam.* This is carried in underground pipes and sold for heating buildings; an article for which there is a ready sale eight months of the year. Exhaust steam being a by-product, it follows that the income realized from its sale is nearly a clear profit. There does not seem to be any good reason, then, why an electric plant should not avail itself of this source of income, where the boiler plant is favorably located for the work. In cases where condensing engines are used, this is given as the reason why the use of exhaust is not called for. In the minds of some managers the fact that condensers are in use closes the case; but does it?

A plain cylinder will use 10 per cent. only of the heat units represented by the fuel consumed. If you add a condenser you can increase the efficiency of your engine 25 to 33 per cent., that is, you then use 13 per cent. instead of 10 per cent. of the heat units. Where is the balance of your heat units? Making due allowance for radiation from boilers and engines, it may be said for a fact, that at least 80 per cent. of the total heat units flows away in the large amount of hot water leaving the condenser. If the manager can make no better use of his steam, then three per cent. is a saving, provided he has free water without pumping. If the company pay water rent or run a pump, it is doubtful if there is any economy. If the condenser is advisable he can run it during the part of a season when there is no market for heat; construct a system of street mains to connect with the exhaust pipe, and disconnect the condenser during the heating season. Each 100 h. p. of boilers will heat 1,000,000 cubic feet of space from the exhaust, worth approximately $3,000 to $5,000, when in continuous use during the season for heating. Nothing like this amount of value can be shown to follow the use of condensers; besides, as has been shown, the condenser does not bring any relief from the hours of idleness each day, when the whole plant is "lying idle and unproductive of anything but interest account."

The case is simply this: Given a certain amount of fuel to be burned under a battery of boilers which produces in steam a certain number of heat units. The best we can do in engine work leaves more than 80 per cent. of these units still in the steam after it has passed the engines, and fully 80 per cent. of the remainder escapes in the water from the condenser if one be in use.

Providing conditions are favorable for turning this 80 per cent. of heat units into money, is it "close business management" if this important source of revenue is neglected?

SOCIÉTÉ INTERNATIONALE DES ÉLECTRICIENS.

The following gentlemen form the council of this society for the current year: President, M. L. Raymond, Director of the Ecole Supérieure de Télégraphie; vice-presidents, MM. Bouillhet and Potier; secretaries, MM. Sarcia and de la Touanne; members of council, MM. Abdank-Abakanowicz, Baille, Baudot, H. Becquerel, J. Boulanger, Brüll, Cance, Cornu, Fribourg, Friedel, Gaudry, Hillairet, Krebs, Meyer, Mildé, Raffard, Tripier, Vaschy, Violle, and Vlasto.

At a recent meeting of the Société Internationale des Electriciens, M. Rechniewski gave the results of some investigations by M. Labour and himself, on the relations between energy dissipation in, and cooling surface of, dynamo armatures. M. Rechniewski allows a rise of 50 degrees C. above the temperature of the surrounding atmosphere. The figures he arrived at in the case of three 2-pole drum machines were 7.14, 6.9, and 7.5 sq. cms. per watt dissipated. With vigorous internal ventilation, only 4.25 sq. cms need be allowed. Finally, in certain armatures of multipolar machines with open interiors and vigorous ventilation, M. Rechniewski concludes that 3.3 sq. cms. per watt dissipated will suffice.

THE RELATIONS BETWEEN ENGINE AND DYNAMO IN RAILWAY WORK.

BY

Chas. Hewitt,

Mr. Wm. Church in his article on "Points on Railway Power Stations" published in The Electrical Engineer of April 27, seems to be more familiar with the steam engine than with the dynamo. He says: "An electric generator can stand an overload, or even an excessive overload, provided it does not have to stand it long. *The question is simply one of heat.*" This very question of heat is one of the worst troubles that engineers have had to contend with. Further, it is not simply a question of heat, but of E. M. F. as well. The E. M. F. of the best compounded dynamos will fall off rapidly with much of an overload, and the frequent lowering of the initial pressure is disastrous to the satisfactory running of the cars. Further, he states that an engine has no such capacity for excessive overload as a generator, but is able to stand an overload of from 20 per cent. to 25 per cent., assuming that the engine is honestly rated.

Following Mr. Church's argument I have reached the following results which differ rather materially from his. Many tests of street railway power stations have shown that for moderate size plants, say 25 cars and over, the *average* load is very close to ⅔ of the maximum load. For smaller plants the average load will fall as low as 50 per cent. of the maximum and even less. In all cases the dynamos should be of sufficient capacity to carry the maximum load without lowering the E. M. F. For maximum efficiency of operation I would suggest that the engine should have a rated capacity half way between the average load and the maximum load. The engine would then operate at an average load of 80 per cent. of its rated capacity, and would only have to carry momentary maximum loads 20 per cent. above its rated capacity, which is within Mr. Church's limit. Assuming a specific case, say we start with a dynamo of 100 e. h. p. The average load would be 66.6 e. h. p. Adding one-half the difference between the average load and maximum load and allowing 10 per cent. for loss in the dynamo we find that the engine should have a rated capacity of 92 h. p. The boiler should be slightly in excess of the average load on the engine, to allow for loss in pipe, etc. Say, for the case in question, we allow 15 per cent.; the boiler would then have a rated capacity of 86 h. p. The arrangement would then be as follows:

Dynamo	100	e. h. p.	rated
Engine	92	"	"
Boiler	86	"	"

Such an arrangement as the above would, I believe, give the highest efficiency of operation, were it not for the fact that short-circuits and similar accidents will persist in occurring even with the best of management. To meet such emergencies the engine should have a margin of power above what the above reasoning would call for, and for plants of any considerable size a spare engine and dynamo is almost a necessity to prevent a shut-down. Further, no plant that runs as continuously as most street railways do should be without a spare boiler. In view of these facts it seems advisable to have the dynamos of ample, but not excessive capacity, and the engine of a rated capacity equal to the power of the dynamo. This I believe is the general practice at the present time. Mr. Church's criticism about "rule of thumb" then does not seem to be so just as he would have us believe.

I would also take exception to his statement that "the engine and dynamo can be fairly trusted to take care of themselves since any ordinary repairing can be quickly made between running hours." If railway companies followed this advice they would get but poor satisfaction. Most roads start at between 5 a. m. and 6 a. m., say, 5.30, and do not stop until 12 or 1 o'clock at night. The hours for repairing would then be from, say, 12.30 to 5.30 a. m. —not the most convenient time for doing even the most ordinary repairing.

DR. JACQUES' EXPERIMENT SHOWING WHAT ELECTRICITY IS.

BY

Victor M. Berthold

In his adress delivered before the American Academy of Arts and Sciences at its recent social meeting at the residence of Hon. Martin Brimmer in Boston, Dr. Jacques brought forward a crucial experiment that would seem to go a long way towards showing that the electric fluid is identical with the ether that fills all space. The experiment at least demonstrates that a current of ether possesses both qualitatively and quantitatively the same properties as a current of electricity.

Although the address has been reprinted in many of the electrical journals, we may say, briefly, that the experiment consists in measuring, with a peculiarly novel and sensitive galvanometer, the electrical effect of the current of ether produced by the rapid motion of the galvanometer through space as it is carried along by the earth in its journey around the sun, combined with its well-known movement towards Hercules.

At the close of Dr. Jacques' address before this learned body of scientists, the discussion took but one path, that of commendation of the beauty and completeness of the experiment.

In an editorial article, printed in The Electrical Engineer of May 18, 1892, the opinion is expressed that Dr. Jacques' experiment does not prove that the electric current is a bodily forward movement of the ether, but does show, what had previously been shown by Prof. Rowland, that a moving electrified body is equivalent to an electric current.

It is to be regretted that the writer of this editorial had not the good fortune to be present and listen to the remarks following Dr. Jacques' address, where the relations between Dr. Jacques' experiment and Prof. Rowland's experiment were fully discussed. It did not occur to this body, comprised of our leading mathematical electricians, that Dr. Jacques was merely proving, in another way, what Prof. Rowland had already proved, but, on the contrary, it was the universally expressed opinion that Dr. Jacques had taken a marked step in advance of our present electrical knowledge.

Nor did it occur to the late Prof. Clerk Maxwell that the movement of a pair of oppositely electrified plates relative to the ether would prove the same thing that would be proved by rotating an electrically charged body about a magnetic needle; for that great mathematical electrician anticipates both the experiment of Dr. Jacques and that of Prof. Rowland (*Electricity and Magnetism*, §§ 771 and 772), though there is this marked difference that, while he describes the experiment that Prof. Rowland afterwards made, almost in detail, he says of Dr. Jacques' experiment: "Since this velocity is about 288,000 kilometres per second, it is impossible to make the experiment above described." It remained for Dr. Jacques to conceive of utilizing and to utilize the enormous velocity of the earth in its journey through space to move his charged plates relative to the ether.

ELECTRICITY ON A SOUTHERN FARM.

BY

A. F. McKissick

THE recent application of the electric motor to ginning and pressing cotton, cutting up feed-stuff, threshing grain, and other farming operations where mechanical power is called into play, is another of the many instances where power transmitted by electricity, furnished from a central station, has proven more convenient, more economical and safer than power furnished by a steam engine.

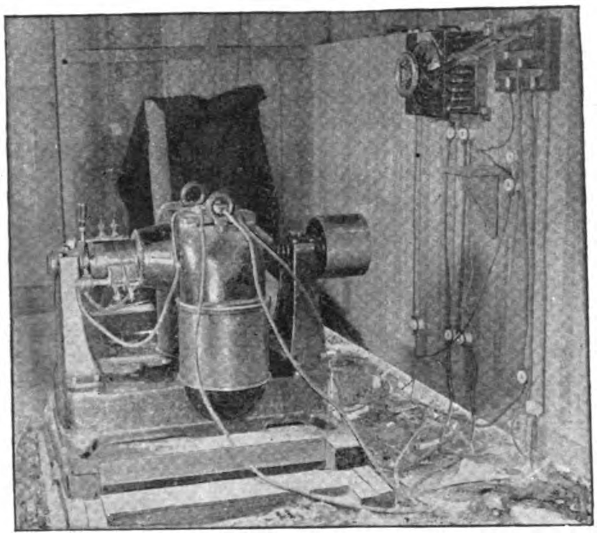


FIG. 1.—MOTOR FOR DRIVING FARMING IMPLEMENTS.

The location of the first plant of this kind is on the farm of the Experiment Station of the State Agricultural and Mechanical College of Alabama, at Auburn, Ala. The station is situated about three-quarters of a mile from the college, and is in every respect a typical Southern farm. One of the necessities on a large farm like this is some source of mechanical power for performing the various operations such as ginning and pressing cotton, cutting up feed-stuff, threshing grain, etc. This power has heretofore been supplied by a 15 h. p. engine and boiler, but it was decided some weeks ago to supplant this by the electric motor, which is furnished with current from a generator in the dynamo-room of the college. This generator is a 12-kilowatt compound-wound Edison, 125 volts, and is run by a 35 h. p. Westinghouse Junior engine, furnished with steam from the steam plant which supplies the mechanical and electrical laboratories. There is also a Brush arc dynamo which lights the campus. The motor is a Thomson-Houston shunt-wound 110 volt 10 h. p. and comprises the device for variation of speed. Owing to circumstances, the dynamo that furnishes the college buildings with lights had to be used as a generator, and the low voltage necessitated a greater loss than would otherwise have occurred. This defect it is proposed to remedy this summer by the installation of a 500-volt system. The generator and motor plants were installed, the poles put up and the wires strung by the students in electrical engineering. A No. 0000 B. & S. wire is used for the outgoing; a No. 6, grounded at each end and at intervals, completes the return.

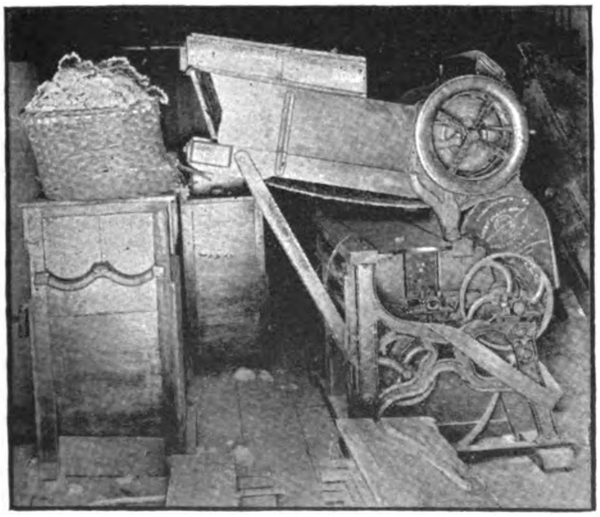


FIG. 2.—COTTON GIN DRIVEN BY ELECTRIC MOTOR.

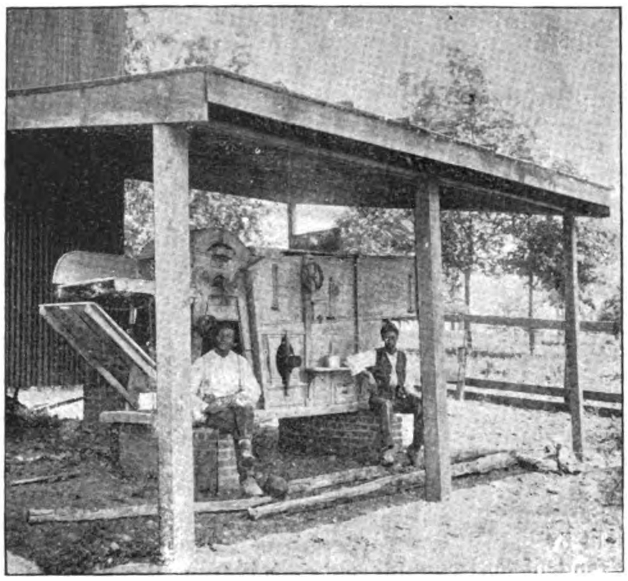


FIG. 3.—THRESHER DRIVEN BY ELECTRIC MOTOR.

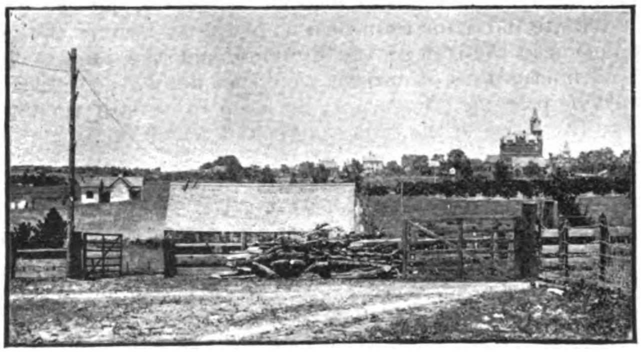


FIG. 4.—LINE AND MOTOR PLANT, AGRICULTURAL STATION, AUBURN, ALA.

The motor, Fig. 1, is belted to a countershaft and from this a belt runs to the feed cutter, gin, screw press, cotton seed crusher and thresher. The feed cutter is used for grinding up oats, ears of corn, shelled corn, peas and all kinds of grain.

In the same room is located the cotton seed crusher. The cotton gin, Fig. 2, and thresher, Fig. 3, are run also from the same countershaft. The silo cutter is used for preparing silo. There is also a corn sheller and separator. Fig. 4 shows a view of the line, the college appearing in the distance.

The steam plant is in operation the greater part of the day, so there is no delay in starting the motor at any time.

The advantages of this plant over the superseded one are its safety from danger to life and property, its safety from damage by fire, its convenience, its economy, its neatness and the advantages necessarily accompanying the centralization of small units into one large plant.

The plant is running successfully and has proven its claims.

THE MAGNETIC EXPLORING COIL.

BY

H. M. Stine

TELEPHONE lines near wires carrying alternating currents, yield by induction a tone in the receiver whose pitch is dependent on the number of alternations. This, although a great annoyance to users of the telephone, has something in its favor—one accustomed to the alternating dynamo may detect a lack of magnetic or electrical balance in the field or armature if, in addition to the fundamental tone, a throbbing, or what may be called "beats," can be heard. These are well-known facts; but that a direct current, especially that used for arc lighting may produce analogous phenomena, is perhaps not so generally recognized. When a dynamo is running we may observe a few details regarding its performance, but after taking note of the current and the potential we must take its magnetic condition largely on faith, and be satisfied with a few inferences. The watt indicator enables us to follow the operation of the steam engine through the varying conditions resulting from changes of load and pressure, but we have no definite indicator to inform us of the molecular changes going on in the iron of the dynamo and the minute and rapid fluctuations of current which we know, theoretically, must be present. Then, too, we seem to be still in doubt as to the cause of the humming sound which is so marked in some dynamos.

The writer has recently made a series of tests with a simple piece of apparatus which yielded results that were not only interesting, but seemed to have an important bearing on the facts just noted. The apparatus employed was an induction coil with the usual bundle of iron wires for the core, and the coil connected to a Bell telephone receiver. In subsequent tests the induction coil of a transmitter was employed and answered the purpose admirably. When the coil was brought near the pole of a dynamo, which, owing to an insufficient amount of iron in its frame, had always shown a large amount of magnetic leakage, a loud musical note was heard, which corresponded in pitch to the annoying humming sound usually emitted by the machine. This entirely agreed with the usual behavior of the machine. When the commutator bars became worn and slightly rounded, this humming was most pronounced. A part of the noise was then doubtless due to the vibration of the brushes themselves, but from the fact that the tone heard in the receiver has been more marked at such times, one is almost forced to the conclusion that the humming is in the iron of the machine, since in this case the variations in current strength would be very marked on the passage of the rounded segments under the brushes.

When the coil was held at the air gap in the field the note was painfully loud, and the intensity of the sound increased perceptibly when it was brought near some bolt heads on the poles, or the edges of the pole-pieces themselves, the best effect being obtained in each case, as a matter of course, when the axis of the coil lay in the lines of force. When the series coil of this compound-wound dynamo was tested the same tone was distinctly heard. By theoretical considerations it is known that the current yielded by a commutated dynamo is not continuous, but intermittent, yet few electricians have ever noted an actual demonstration of this fact. It may be shown by a series of mirrors, as in the case of alternating currents, but here we have an audible effect clearly caused by these pulsations.

The fact that the same tone is produced by the pole-pieces, and in fact by any portion of the frame in the magnetic circuit, shows that there is a constant magnetic flux in the field corresponding to the variations in the current. We would be led to infer this, too, from the usual action of the telephone; but from these facts we reach the conclusion that the strength of field in any dynamo is simply a mean value of these rapidly recurring fluxes.

A Thomson-Houston continuous current dynamo of the "motor type" was also tested and very little external leakage could be detected. A local short-circuiting of lines of force was, however, noted in the lower portions of both shunt coils. As in this type of dynamos, there is considerable latitude to the adjustment of the brushes between non-sparking points; the person in charge of this particular dynamo has experienced some difficulty in adjusting the brushes accurately to the exact point of maximum efficiency. The coil was held near the series winding, and the correct position of the brushes was readily located with considerable accuracy by the intensity of the note in the receiver. The arc dynamo of the same company yields some very interesting results. The nuts on the ends of the yoke bars produce a louder tone than any other portion of the frame, excepting the sharp edges at its ends. There appears also, to be a well-defined line of leakage extending from the lower portion of the negative end of the frame to the upper part of the positive end. If the coil is moved around the commutator the position for maximum efficiency for the brushes is clearly indicated. It is also shown that there is a deformation of the external field surrounding the winding, corresponding to the forward shifting of the magnetic axis by the rotation of the armature. Each dynamo can be shown to possess an individual tone or pitch. In the 50-light arc machine this is a deep bass, while in the smaller dynamos it is much higher, owing to greater armature speed.

Besides being able to indicate proper working conditions, the coil may be used to point out other defects than those noted above. A lack of magnetic or mechanical balance in the armature core, or electrical balance in the coils, or a bad contact on some segment, would each produce its appropriate tone, readily to be distinguished from the fundamental tone of the dynamo itself. This same device could be used to determine the condition of arc lamps on any circuit. If they were in good working order their adjustment would occasion but slight variation in the intensity of the current tone.

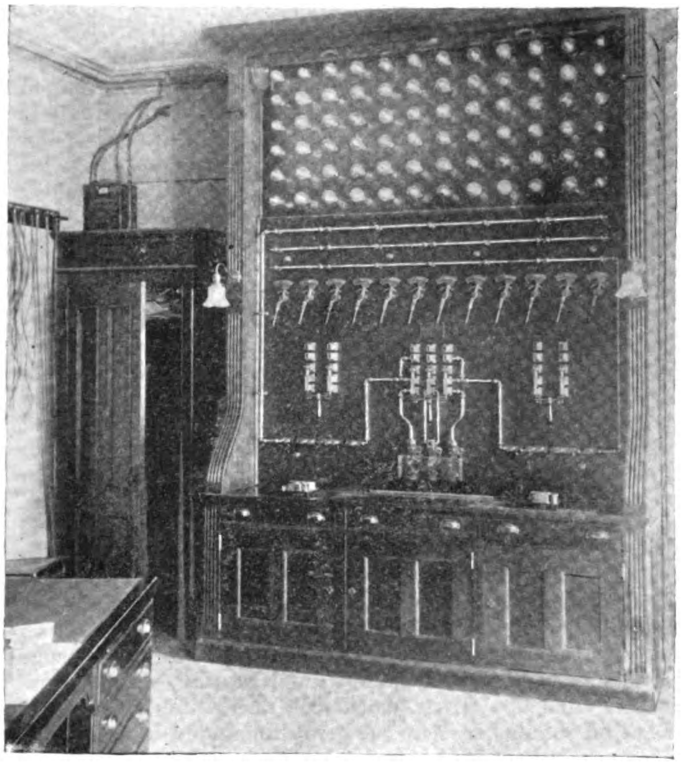
PREVENTION OF SPARKING IN DYNAMOS.

AN ingenious arrangement for preventing sparking between brushes and commutators has recently been devised by M. Deprez. The commutator is made in two parts so placed that the conducting bars and insulating spaces, which are of equal width, alternate with one another in the two halves. The current is collected by two brushes on each side joined by a resistance from the centre of which the main circuit is taken. A battery of accumulators added to this circuit has just sufficient E. M. F. to oppose that of the coil undergoing short-circuit, and thus the inventor is said to have run high pressure machines with absolutely no sparking.

THE TEST BOARD OF THE BOSTON INSPECTION OF WIRES DEPARTMENT.

Soon after the department for the inspection of wires was put on an active footing in May, 1891, Inspector of Wires B. S. Flanders, early seeing the necessity of some reliable means for testing such apparatus as might come before the department, such as the carrying capacity of wires, switches, cut-outs, etc., the testing of insulation, automatic cut-outs and other safety devices, designed and had built by Messrs. J. C. Cushing & Co., electro-machinists of Boston, the test board shown in the accompanying illustration, which through the courtesy of Inspector Flanders, the representative of The Electrical Engineer was able to see in actual operation.

The case stands 11 feet high and is 7 feet 6 inches wide, and is made of highly finished quartered oak. The lower portion is divided into three cupboards for the tanks used in testing the insulation of wires, etc. Just above the doors to these cupboards are two drawers, one on each side of the case, with a blind drawer between them. The roll to this case is said by the manufacturers to be the largest ever made, it being 11 feet long and 6 feet 6 inches wide. In the illustration the roll is thrown up, showing the board ready for use.


Test Board of the Boston Inspection of Wires Department.

On the table to the board are a Weston voltmeter and amperemeter, which can at any time when needed be easily thrown into circuit. The background upon which the bus-rods, switches, etc., are mounted, is a solid piece of slate without a flaw, 6 feet 6 inches wide and 4 feet 10 inches high; above this is a resistance bank of 72 lamps on a polished surface of quartered oak.

The board is wired up to be used for either the 3-wire or 2-wire system. With the large double-throw knife switch thrown down, as shown in the illustration, the current enters the safety catches immediately below the switch, from the Edison 3-wire system, and distributes over the board. With the switch thrown up, the board is fed by the alternating current of the Boston Electric Light Co. which enters through a set of safety catches on the back of the board and then distributes over the board, using the two outsides as the positive pole and the neutral as the negative pole.

The two double-throw switches seen to the right and left of the main switch control respectively the two sides of the board. Immediately below these switches and forming part of the bus-rods are metallic blocks, separated by air spaces, and with screw caps at each end for connecting anything in circuit which it may be necessary to test, and which is thrown into circuit by removing the plug between the blocks. When these switches are both down, as shown in the illustration, the current for the board is evenly divided, part going over the bus-rod running from the right of the switch and part over the left bus-rod. With the left switch up and the right switch down the whole current is fed through the left or top bus-rod; with both switches reversed, that is, with the left switch down, and the right switch up, the whole current passes through the right bus-rod.

The row of twelve switches to be seen just below the bus-rod control the 12 circuits into which the lamps on the board are divided and so that the lights can be thrown into circuit in such manner that the current on the board can be increased gradually until the maximum current or capacity of the board is reached. The wiring in the rear of the board is done with a rubber-covered wire enclosed in conduit tubing. It was wired under the immediate supervision of the inspection of wires department, and is naturally done in the most approved manner. There are connections on the rear of the board by which an auxiliary resistance may be thrown into service, thereby increasing the ampere capacity of the board beyond what the department is ever apt to need. The appearance of the board is very ornamental, and on each side of the front of the case is an ornamental bracket light which adds materially to the appearance of the case when closed.

BREAKING STRAIN OF VARIOUS JOINTS IN HARD-DRAWN COPPER TELEGRAPH WIRES.

BY

Jones

With a view of ascertaining the relative value of joints of different kinds that are used in the United States with hard-drawn copper wires, Mr. M. M. Davis made the subjoined tests at the factory of John A. Roebling's Sons Co., at Trenton, N. J. The samples used in the tests were No. 10 B. and S. gauge, 166 lbs. per mile, with a breaking strength of 520 lbs. The following results were obtained, the description of the joint being given at the head of each table:

Ordinary Twist Joint, 7 turns each side of centre. Soldered.

No. of sample.	Broke at lbs.	No. of sample.	Broke at lbs.
1	485	6	370
2	490	7	460
3	450	8	360
4	430	9	450
5	440	10	380

McIntyre Sleeve, 4½ inches, 3 full twists. Not soldered.

No. of sample,	Pulls out at lbs.	No. of Sample.	Pulls out at lbs.
13	240	18	310
14	300	19	450
15	380	20	370
16	320	21	350
17	370		

Ordinary Twist Joint, 7 turns each side. Not soldered.

No. of sample.	Lbs.	No. of sample.	Lbs.
22...1½ turns in centre. Pulled out....	250	28...2 turns in centre. Pulled out....	190
23...½ turn in centre. Pulled out....	350	29...2 turns in centre. Broke.........	290
24...½ turn in centre. Broke	340	30...1 turn in centre. Pulled out ...	260
25...1 turn in centre. Broke	320	31...1½ turns in centre. Broke.	265
26...2 turns in centre. Pulled out ...	225	32...1 turn in centre. Pulled out....	250
27...2 turns in centre. Broke.........	340		

Western Joint, 3-wire twist, made by twisting a short piece of the same wire in the ordinary twist joint; 7 turns each side of centre. Not soldered.

No. of sample.	Lbs.	No. of sample.	Lbs.
33...1 turn in centre. Pulled out....	340	39...1 turn in centre. Broke.........	430
34...1 turn in centre. Pulled out ...	320	40...¾ turn in centre. Pulled out....	340
35...1½ turns in centre. Pulled out....	320	41...¾ turn in centre. Pulled out....	310
36 ...1 turn in centre. Pulled out....	400	42...1½ turns in centre. Pulled out....	370
37. .1½ turns in centre. Pulled out. .	370	43...1 turn in centre. Pulled out ...	350
38...½ turn in centre. Pulled out ...	369		

Twist Joints, 7 turns each side of centre. Dipped in solder. Acid flux.

No. of sample.	Lbs.	No. of sample.	Lbs.
1.............Pulled out.	360	3.. . ... .Pulled out.	300
2............. "	340	4.............Broke.....	405

Same, resin flux.

No, of sample.	Lbs.	No. of sample.	Lbs.
5 ....Broke.....	280	10........... Broke......	445
6............Pulled out.	380	11. .... "	290
7............Broke......	310	12............ "	330
8.... . .... "	310	13............ "	300
9............ "	400	14.......... . "	350

Twist Joints, soldered by soldering iron and acid flux.

No. of sample.	Lbs.	No. of sample.	Lbs.
1................. Broke.	355	6 .... Broke.	495
2................. "	520	7............ .... "	490
3....... .... "	510	8................. "	520
4... .... "	510	9................. "	505
5................. "	510	10..... . ... "	500

Twist Joint. Solder poured on. Resin flux.

No. of sample.	Lbs.	No. of sample.	Lbs.
1.. ....Broke.....	490	6......... .. ....Broke.	460
2............Pulled out.	390	7................. "	440
3....... ....Broke.....	470	8...... .... "	420
4............. "	440	9........ .... .. "	500
5............. "	460	10.... ... . "	360

Twist Joints, 7 turns each side of centre. Solder poured on. Tallow flux.

No. of sample.	Lbs.	No. of sample.	Lbs.
37A ....Broke.	475	40A...............Broke.	465
38A.............. "	500	41A............... "	475
39A.............. "	470		

Britannia Joint, 2 inches. Solder poured on.

No. of sample.	Lbs.	No. of sample.	Lbs.
42. Tallow flux...Broke.	490	48. Resin flux....Broke.	500
43. Resin flux ... "	470	49. " .... "	490
44. " .... "	480	50. Soldering iron and acid flux...Broke.	495
45. " ... "	490	51. Soldering iron and acid flux...Broke.	490
46. " .... "	485		
47. " .... "	485		

Twist Joints, 7 turns each side. Solder poured on. Resin flux.

No. of sample.	Lbs.	No. of sample.	Lbs.
52...............Broke.	465	55 ....Broke.	470
53 .. .. "	495	56 ... . "	470
54.............. "	470	57...... .. .. "	465

SUMMARY.

			Average breaking strain. Lbs.	Average per cent. of break'g.
10	samples.	Twist joint. Solder poured....	431	83
9	"	McIntyre joint. Not soldered..	343	66
11	"	Twist joints. Not soldered....	279	53
11	"	Three-wire joints. Not soldered.	356	68
4	"	Twist joints, "dipped." Acid flux..........................	351	69
10	"	Twist joints, dipped. Resin flux........................ ..	339	66
10	"	Twist joints, soldered with iron. Acid flux	490	94
10	samples	Twist joints, solder poured. Resin flux..................	443	85
5	"	Twist joints, solder poured. Tallow flux	477	91
10	"	Britannia joint, 2 inches solder poured........................	488	94

Copper wire is taken at 520 lbs. breaking strain for comparison in "Average per cent." column.

RELATIVE PROPORTIONS IN RAILWAY POWER PLANTS.

BY

D. D. Book.

The very interesting paper by Mr. W. Lee Church in The Electrical Engineer of April 27, on the relative boiler, engine and generator capacities for railway work brings up a matter of great immediate interest, and one which has not been discussed heretofore.

The most difficult question of the three to settle is the capacity of the engine. This will be largely determined by the type adopted, and any general rule will only hold good for one particular class. Mr. Church, of course, appreciates this point, and in his last paragraph says that his remarks apply only to the particular type of engine under discussion. The fact that this engine is a successful, non-condensing compound, proves it to be of a special and unusual type, and conclusions drawn from its performances would not be applicable to other engines.

The number of horse power to be installed in a railway power house is, I take it, a factor of nearly as much importance as the type of engine. In a small station, where variations in the load occur with the startling rapidity given in Mr. Church's diagram, two desirable features of every steam engine are elevated to the most pre-eminent importance. It must be able to open up its admission valves, follow through a considerable portion of its stroke, and thus "walk away" with the heavy loads imposed upon it; and it must have sufficient mechanical strength to stand these overloads. Since makers have built railway engines strong enough (which was not done at first) the fact that they have been able to meet the first condition has been the keynote to railway success. The two reasons for this are that the engine in a small station, which occasionally runs at a great overload, will have its mean point of cut-off somewhere near the point demanded by economy; and we are required to buy less horse power of engines. These appear in one form or other to the directors about to re-equip a whole road. The fact that no non-condensing compound will carry anything like the proportion of overload of a single cylinder engine obliges us to install a much larger engine of the first type than of the second. This is why Mr. Church puts the line showing the rated capacity of engine so high. This engine would have its mean load too small, and the cylinder condensation would be great, due to the large surface of the cylinder; therefore its economy would not be high; also it would be more expensive than a single cylinder not only on account of the greater horse power, but each horse power costs more for a compound than for a simple engine. All this is aside from the question whether any non-condensing compound can be built to have no drag in the low pressure cylinder at all loads. The only engine for which claims are made on this point is, I believe, the one made by Mr. Church. There is a case in point in a small station in Brooklyn, N. Y., where one high pressure tandem engine usually sufficed to carry the load. At instants of light load, the drag in the low pressure cylinder was so great that it was disconnected, and the engine run as a single cylinder.

When we come to large stations of, say, 800 and over amperes output, selection of the engine capacity is much simpler. I recently watched the ammeter of a station of this size for about three-quarters of an hour in the busiest part of the day. The highest reading was 900, and the lowest 400, but this last reading occurred but once, and that only for a short time. There was not a rapid fluctuation of load at any time. Any good single cylinder engine or multiple expansion condensing engine is likely to give satisfaction when working on the steady loads of large stations. Let the horse power required for mean load be the rating of the engines, rated on the rule of the Institution of Mechanical Engineers. This rule gives an engine n h. p. when it is capable of carrying a load of $n + \frac{1}{3} n$ h. p.

Mr. Church must know of some remarkably fine boiler when he advises making the boiler capacity equal to the mean load. The man who would put in any boiler with which I am familiar on this basis would have unending trouble from the hour of starting to the time of getting more boilers. There is a typical case of this, not far from New York, where the mean load in the afternoons is almost exactly 700 h. p. The boiler capacity is just 700 h. p. The result is that every boiler is in use, and being fired in Mississippi River racing style. The horror with which the firemen regard a slight drop in pressure is only equaled by the gravity of the situation. Should the pressure drop, more pounds of steam are required to do the same work; and this the boilers cannot supply unless they have ample reserve capacity. In the case mentioned, two new boilers are on their way to the station.

Probably most electrical engineers will agree with me in the statement that a generator should not be compelled to stand 75 per cent. of overload, as would be the case if we were to follow Mr. Church's advice. Had observations been taken a longer time, it is certain that we would soon find a current much greater than the maximum in the figure. The maximum would without doubt give an overload of 100 per cent. But let us stick to 75 per cent.; also let us assume that we would not have an eye to a future increase of business in designing our plant. This 75 per cent. overload would risk throwing off the belt, bad sparking, and blowing the fuse or magnetic cut-out. It would also decrease the efficiency and nothing would be gained except the difference in cost between this generator and one of proper size. The objections urged against prodigality in engine capacity do not hold for the dynamo. The dynamo has a good efficiency from loads considerably above its capacity down to 10 per cent. of full load. Also, as an increase in horse power does not nearly bring a corresponding increase in cost, we are justified in buying dynamos of ample capacity. As a case in point, I remember seeing the cut-out act three times in as many minutes on a road of medium size. This is a great nuisance, and is bad practice.

To sum up with reference only to the small road under discussion: Rate the capacity of the generator at 128 amperes (the present capacity of the engine). Rate the capacity of the boiler at 96 amperes (a trifle below the present generator capacity). And rate the capacity of the single cylinder engine at the mean load of 64 amperes (the present boiler capacity). The engine to be rated at the horse power given at one-fifth cut-off. Add a certain percentage to these quantities, depending on local conditions for increase of business. The result, I believe, would be satisfactory to every one from the president down to the fireman.

MR. EDISON HONORED.

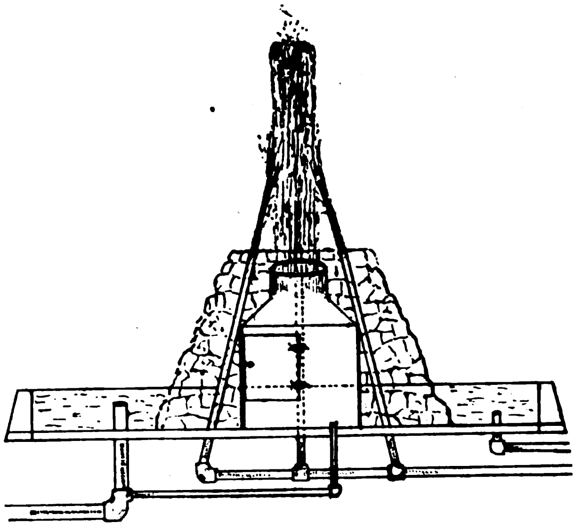
The London Society of Arts prize, consisting of a medal, the prize having been founded in memory of the Prince Consort, has been awarded to Thomas A. Edison. The medal has previously been awarded to Faraday, de Lesseps, and most of the other great scientists.

AN ELECTRIC FOUNTAIN AT WASHINGTON, D. C.

A most attractive novelty in the shape of an electric fountain is now being constructed at Bethesda Park, a suburban pleasure resort near Washington, D. C.

The basin is constructed of broken stone and cement, enclosed by a wall two feet high, the entire structure being lined inside and out with Portland cement. In the centre of this basin is a vault 6 feet square and 6 feet high with an entrance in the side. The vault is covered with a rustic pile of rocks, and gives the appearance of a rocky mound, in the centre of which three streams of water rise at equi-distant points from each other around a skylight in the roof of the vault. Overflow, feed and return water pipes are supplied as may be seen in the accompanying sketch.

In the centre of the vault is located an electric projector of 5,000 candles; by means of a reflector, double-convex lenses and mirror, all of this enormous volume of light is concentrated and thrown up through the skylight of the vault in a perpendicular column, 24 inches in diameter. Between the mirror and the sky-light, pivoted on one side of the same is a wheel carrying colored lenses, viz., red, green, blue, yellow and white, which rotates slowly by an individual $\frac{1}{3}$ h. p. motor, giving the column of light a complete change of color every thirteen seconds.



Electric Fountain at Washington, D. C.

The three columns of water rising as they do at equidistant points around the centre, are inclined at such an angle that at a height of 40 feet they would unite in one column, break and fall in broken streams down again. The column of light, rising in the centre of the three streams, brilliantly colors the whole exterior as well as the interior, viewed from whatever side according to the color thrown over the lens, until it strikes the point where the three columns unite and break, where the light also breaks; and as the water turns to descend the light is reflected in every direction, making a magnificent effect, which can only be likened to a volcano in full operation throwing out a continuous stream of molten lava of constantly changing color.

The water for this fountain is supplied from a 6,000-gallon tank, through a Gould's "Triplex" pump, operated by a 5 h. p. Excelsior motor, delivering 80 gallons of water 40 feet in the air every minute. The electrical projector is of the New American Electrical Arc Light Co.'s pattern, and a C. & C. motor operates the color machine.

The complete cost of this fountain is about $4,000; it was designed by Mr. L. D. Bliss, electrical expert of the installing firm, Messrs. Congdon, Bliss & Daniels, of Washington, D. C.

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In the establishment of a principle, it is of the first importance that all probable suggestions relative to it may be subjected to critical examination and tried by the test, as far as possible, of experience; it is in this way that science is advanced.—Joseph Henry.

THE ECONOMY OF CONDENSING ENGINES.

STEAM engineering has now come to play such a prominent part in the engineering work of electric central stations that discussions relating to this branch of the equipment have been given full scope in our columns, and the latest has, we hope, resulted in a clearer understanding of the question involved. That the economy of a central station, other things being equal, will in general be higher when condensing engines are used is now generally recognized. But there is a phase of this question which is now presenting itself for the consideration of central station managers, and which deserves more attention than appears to be devoted to it at present. The position is well put in the article by Mr. I. H. Babcock, in this issue. He asks the very pertinent question whether, in brief, it pays better to use the exhaust steam for condensing purposes or to distribute it to customers for heating purposes. The problem is one which can, we believe, be figured out without much difficulty in each particular case. The concrete example which is given by Mr. W. F. Collins on another page, of such a plant at Springfield, Ill., goes far towards showing that the position maintained by Mr. Babcock is a tenable one. The question simply resolves itself into striking a balance between the saving in fuel effected by condensing and the income derived from the sale of the exhaust steam after deducting the expense incurred for the distributing plant. Where stations are situated in proximity to thickly settled districts, as in most cases at present they are, and are maintained in operation during twenty-four hours of the day, the advisability of investigating this method of increasing the returns from central stations needs no further pointing out. Indeed it may not be generally known that one of the largest central station companies in this country now seriously contemplates the turning over, as it were, of its exhaust steam to a separate company, organized solely for the purpose of distributing this product for heating and other purposes. With these examples before us it is not difficult to discern in what direction the work of the electric central station of the future may be carried. As we have often pointed out, central stations operated on a business basis are not established to promote a special method of manufacturing current, but by carrying on a business in light, heat and power with any and every form of current, to earn dividends. If incidental to the sale of current, a profitable business can be done in the sale of exhaust steam, it behooves every local company to look into the subject for itself very thoroughly.

WHAT ELECTRICITY IS.

UNDER the above caption we took occasion in our issue of May 18 to express some doubts as to the sufficiency of the experiments undertaken by Doctor W. W. Jacques to warrant the conclusion arrived at by him that the electric current is a bodily forward movement of the ether. Our remarks, we may state, were called forth by the perusal of a pamphlet issued by the American Academy of Arts and Sciences, before whom Doctor Jacques delivered his address. The pamphlet contained merely that, so that we were entirely unwitting of the discussion which followed and which Mr. Berthold says was participated in by some of our "leading mathematical electricians." Nothwithstanding this, our original opinion remains unchanged in so far as regards both the sufficiency of Dr. Jacques's experiments and the validity of his conclusions. We are perfectly willing, however, to accord to Dr. Jacques the credit due him for having conceived this method of utilizing the enormous velocity of the earth as a means for carrying out the experiments only hinted at by Clerk-Maxwell. Mr. Berthold's note on this subject will be found in our pages this week.

THE BREAKING STRAIN OF WIRE JOINTS.

IT is an axiom in mechanical designing that the strength of any structure is that of its weakest member, and the application of this rule to electrical work is eminently exemplified in the construction of overhead electrical conductors. Joints are of necessity of frequent occurrence, and hence it becomes all the more important to take special care in order to avoid any weakening of the lines at such points. Beginning with the early days of the telegraph this was well recognized, and from that time until the present not a little thought has been given to the devising of joints in line wires, with the result that a variety have come in more or less general use. With a view of obtaining independent and reliable information as to the merits of these different types, Mr. Francis W. Jones, electrician of the Postal Telegraph Co., confided to Mr. M. M. Davis the testing of a number of joints, and the results of these tests are given elsewhere in this issue. They show that in this detail, as in all others in electrical work, care and attention are necessary in order to secure the best results. Some of the joints in common use, like the ordinary unsoldered twist joint, proved to be little more than half the strength of the remaining part of the wire, while on the other hand the Britannia joint gives nearly the full strength of the wire. It should be pointed out, however, that these tests show merely the character of the various joints as related to hard-drawn copper wires, and that in all probability the ratio of breaking strain would vary for different material, as hard-drawn copper wire exhibits peculiarities which are not possessed by iron or steel, or indeed by soft copper.

ELECTRICITY BUILDING AND THE EXHIBITORS.

A CIRCULAR about to be issued by Prof. John P. Barrett, chief of the Electrical Department of the World's Fair, states that there will be, according to the latest plans, 500 h. p. for the operation of motors in Electricity Building, 500 h. p. for arc lights, 500 h. p. for incandescents, and a reserve of 500 h. p. for extra service. All the generating of current is to be done in what is known as the general power plant, all the generators being installed at that point, adjacent to steam power of like capacity, and thence the circuits will run through a subway to the Building. Fireproof vaults will also be provided for transformers. The Building will be divided up into sections, and each section will be allotted to an exhibitor, who will have to install his own generator, belting, cable, wires, lamps, motors, etc., according to the service undertaken, as well as pay the pro rata of the costs incident to the erection of machinery. It is also intended to make a charge to exhibitors who want special light and power but do not come in under the above provisions. The object of this is, that the Building may not be a source of expense to the Exposition Management. If these plans be carried out fairly and justly, there should be no ground for complaint in any quarter.

CENTRAL STATION PROPORTIONS.

ALTHOUGH the importance of maintaining certain proportions between the boiler, engine and dynamo capacity in railway power stations was recognized even in the early days of electric railroading, the lapse of time has only further emphasized the necessity of carefully considering these factors in designing central stations. In discussing this subject in a recent issue, Mr. W. Lee Church argued very ably that with a given maximum power called for, boilers and dynamos could be installed considerably below the maximum capacity demanded at any one time, owing to the capacity of these elements for maintaining considerable overload for short periods of time. Two engineers in our columns this week take issue with Mr. Church, and point out difficulties which are likely to arise in a station which is not liberally equipped to sustain a heavy overload for a considerable length of time. Such conditions frequently arise in electric railway practice and hence should be provided for, they say. It seems to us that one of the elements in this important question is the manner in which the station and road are run. Meantime, Mr. Church's rejoinder to these criticisms will be eagerly looked for.

LIGHTING THE WORLD'S FAIR.

ONE of the most extraordinary of recent electric lighting episodes appears to have come to an end—though, perhaps, it is hardly safe yet to say that an end has been reached, for should Mr. Westinghouse decline to furnish a bond for $1,000,000, the contract for incandescent lights for the Chicago World's Fair will still be open. It is now stated that after all the hurly-burly of the past month, Mr. Westinghouse has been awarded the contract for 92,622 lamps, on the alternating system, at $4.25 per lamp, or $393,643 in all. Perhaps Mr. Westinghouse can figure out some profit in this, but we are afraid that he must look for his return very largely in the advertising that will come from the fact that the Westinghouse Company is doing the work. Possibly, as we have suggested, Mr. Westinghouse may not care to put up so large a bond, and the amount does seem rather heavy, but he is not the kind of man to stop short after having gone so far.

The Telephone as a Galvanoscope.

THE use of the telephone as a galvanoscope, especially when employed in connection with portable testing apparatus, though often pointed out, has frequently met with unsatisfactory results owing to the fact that the complete silence which would indicate a balance in the Wheatstone bridge can rarely be obtained. The reasons for this are very clearly pointed out by Prof. Brown Ayres in another column. He shows that when employing a circuit breaker we are not dealing with a simple harmonic current variation but with a complex one, so that if a balance be obtained for one component there are others still which would give indication of their presence in the telephone. The remedy for this is pointed out, but unfortunately cannot be generally applied in practice. The employment of the telephone in a somewhat analogous manner for the study of the distribution of magnetism in dynamo-electric machines is also treated, by Prof. W. M. Stine, in this issue, describing how the telephone may be put to very practical use, not only in finding the best working condition of the machine itself, but also that of the arc lamp circuit.

Lord Kelvin on "Kelvins."

IT appears that Lord Kelvin is not particularly "stuck" on the use of his new title as the name for the Board of Trade unit, and that as a matter of fact a new name will not be introduced, owing to his criticism of it during the earlier stages of its adoption by the Board. This should be a great relief to our witty correspondent, Dr. Park Benjamin, who cannot get over the fact that Sir William Thomson has been willing to accept a peerage, nor forgive Mr. Lockwood for his complacent acquiescence in the state of things that allows a distinguished scientist to become a baron. We must say, for ourselves, that the only saving grace of such a system as the English peerage and "beerage" is seen when the honor—for it *is* an honor in England—is conferred on such men as Tennyson and Thomson.

PRELIMINARY NOTE ON SOME TESTS OF THE CARHART-CLARK STANDARD CELLS.

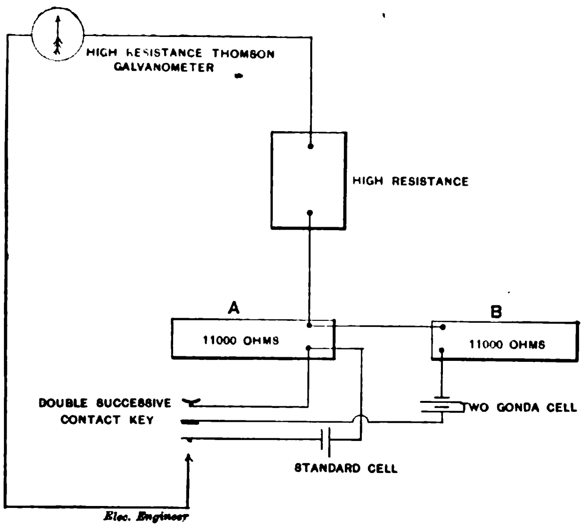
BY

Percy. Matthews & James E. Ives.

Johns Hopkins University.

The following tests were made to determine the relative variation of E. M. F. between individual cells and of the E. M. F. of a given cell with temperature. Six cells were sent to us directly by Professor H. S. Carhart, precisely the same as those supplied by him to Messrs. Queen & Co. They were received on February 14, and first tested March 12.

The arrangements for the test are shown by the following diagram:



METHOD OF TESTING STANDARD CELLS.

These will be seen to be the same as in the method used by Lord Rayleigh and Mrs. Sidgwick in their test of the Clark standard cells. The total resistance used in the two boxes A and B was 20,000 ohms. The ohms in A required to balance a cell are obviously proportional to its E. M. F.

The following are the results of our first test, Table I:

TABLE I.

No. of cell.	Temperature of cell in deg. C.	Ohms in A to balance.	Ohms in A to balance at 15° C.
227	22.3	10,666	10,696
228	23.8	10,660	10,697
229	23.2	10,664	10,698
230	23.2	10,664	10,698
231	24.2	10,662	10,700
232	22.9	10,663	10,696

The ohms to balance at 15° C. are deduced by means of the formula given by Prof. Carhart, viz.:

$$E_t = E_{15^\circ}\,[1—.00039\,(t^\circ—15^\circ)].$$

The cells were next immersed in a water bath in order to compare the E. M. F. more nearly independent of temperature. The following results were obtained in this way, Table II:

Cell No. 230, which, it will be seen, has the lowest E. M. F., had two days previously been placed on a short circuit of 15,000 ohms. On account of the proximity of the water and the very high internal resistance of these cells it is possible that the terminal P. D. was reduced, due to leakage, by something of the order of 1 in 10,000.

TABLE II.

No. of cell.	Temperature of cell in deg. C.	Ohms in A to balance.	Ohms in A to balance at 15° C.
227	13.2	10,647	10,640
228	13.3	10,644	10,637
229	13.2	10,646	10,638
230	13.2	10,643	10,636
231	13.1	10,646	10,639
232	13.2	10,644	10,637

From these tests, therefore, all that can be fairly concluded is that the variation of the six cells between themselves is not greater than 4 in 10,000, and that from the mean the variation is not greater than 2 in 10,000.

The cells were then tested for the accuracy of the temperature coefficient given by Professor Carhart in the following way: Cell No. 229 was immersed in a water bath with a thermometer alongside of it, and balanced at different temperatures. The temperature of the water was varied and the water stirred. In order to check the "Gonda" cells for any change in their E. M. F. during the time of the experiment a Carhart-Clark cell, set up in its brass case with a thermometer in the hole provided for that purpose, was balanced against the Gonda cells.

TABLE III.

Ohms to balance cell at const. temp. at 15° C.	Temperature of cell under test in deg. C.	Corrected ohms to balance cell under test. Observed.	Ohms to balance from coefficient .00039. Calculated.	Difference in parts in 10,000.	
10,582	11.6	10,618	10,615	2	Cell No. 229.
10,580	15.2	10,600	10,600	0	
10,581	19.1	10,584	10,584	0	
10,580	24.2	10,562	10,563	1	
10,579	28.2	10,546	10,546	0	
10,578	37.6	10,509	10,507	2	
10,575	29.6	10,548	10,541	2	
10,575	24.6	10,562	10,561	1	
10,575	20.0	10,582	10,580	2	
10,572	14.9	10,603	10,601	2	
10,571	9.5	10,625	10,624	1	
10,573	7.7	10,628	10,631	3	
10,600	10.7	10,612	10,612	0	Cell No. 228.
10,600	20.6	10,575	10,571	4	
10,600	24.2	10,557	10,556	1	
10,599	30.7	10,526	10,529	3	
10,598	40.1	10,491	10,491	0	
10,608	50.8	10,449	10,445	4	
10,599	41.6	10,479	10,484	5	
10,598	31.4	10,525	10,526	1	
10,598	25 2	10,552	10,552	0	
10,598	14.8	10,591	10,595	4	
10,598	4.4	10,638	10,638	0	

In Table III the column to the left indicates the change in E. M. F. of the Gonda-Lechanché cells, for which the ohms to balance in the next column but one are corrected. This cell was not one of the lot sent to be tested.

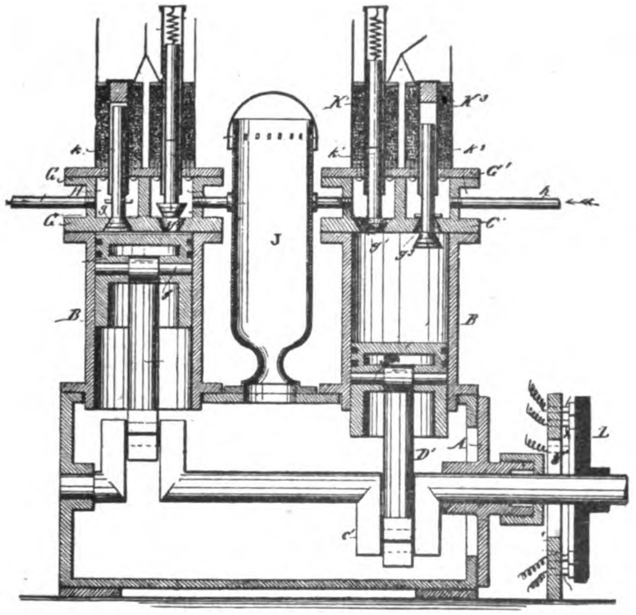
The first set of the above readings was taken on cell No. 229; the second on cell No. 228. We place more reliance on the first test as the temperature was varied more slowly. The only difference in the arrangements for the two tests was that in the second case the cell used to check the Gonda cells was immersed in another water bath with a thermometer. The temperature of this cell varied 2° C. in six hours.

THE DITTMAR AND FALKENHAUSEN VACUUM PUMP.

With the recent tremendous growth of the electrical business and the manufacture of incandescent lamps in particular, inventive genius has ever been busy devising new schemes and apparatus for facilitating and cheapening the process of manufacture. As the exhausting of the lamps is probably the most exacting detail of their manufacture any improvement in apparatus for this purpose cannot fail to be of interest.

The accompanying illustration shows a sectional view of an electro-mechanical vacuum pump devised by Messrs. A. A. Dittmar and H. F. Falkenhausen, of this city. As will be seen, two cylinders, B B′, 6 inches in diameter, are mounted vertically upon a crank chamber, the pistons being connected to the two opposite cranks by short connecting rods, and the cylinders closed by tight fitting casings G G′ at their upper ends.

These casings are divided into two compartments, each carrying a solenoid, as K K′, tightly screwed down, with an oil groove surrounding it. The inside compartments connect by a discharge pipe with the trap pipe J mounted upon the crank chamber, while the outside compartments connect with the vessel H H, to be exhausted. The crank chamber, cylinders and trap are completely filled with oil, which is allowed to stand about two inches higher than the top of the cylinder.



The Dittmar and Falkenhausen Vacuum Pump.

The main feature of this pump is the valve mechanism. Two valves such as $g\,g^2$ are seated in each compartment, one tapering upward and the other downward. Each valve stem forms the core of a solenoid excited by a current from any source, and controlled by a commutator L which is carried on the crank shaft between the pulley and the crank chamber. The commutator consists of two half rings each covering a different part of the periphery, and fed simultaneously by a brush pressing against it. Two other brushes press against the cut sections of the commutator and feed the solenoids.

The action of this arrangement will be easily understood. As the piston has just reached its highest point, and starts on its downward course, one of the brushes at the commutator comes into contact with the section connected to the wire leading to the solenoid. This solenoid, which operates the discharge valve g^2 draws the core up and holds it there until the brush leaves its section of the commutator, which will take place the moment the piston starts on its upward course, when it will be released to allow the air or gases drawn down from the lamps or vessel, to be exhausted. At the moment the piston rises, the exhaust valve is closed by the section of the commutator coming in contact with the solenoid operating it and remains in this position up to the moment the piston starts on its downward course, when the current is interrupted, the exhaust valve g opened, the discharge valve g^2 closed and the operation is complete. The action is entirely automatic. Many efforts have been made to construct a mechanical pump, to displace the mercury pump, but owing to the use of stuffing boxes necessary to operate the valve mechanism, more or less leakage has always taken place. In this pump these obstacles are claimed to have been overcome by the use of the solenoids. By the avoidance of stuffing boxes the inventors of this new pump claim to have overcome all the difficulties heretofore encountered in the use of mechanical vacuum pumps.

We have recently had occasion to see the pump described above in actual operation and on a test it was shown that after leaving this pump, the air remaining in an ordinary 16 c. p. lamp bulb was no greater in volume than a pin head. The pump which, on account of its simplicity, is exceedingly cheap to manufacture is being exploited by Messrs. A. L. and C. F. Reinmann, gentlemen whose names are well known in connection with incandescent lamp manufacture in this country.

MEASUREMENT OF RESISTANCES BY ALTERNATING CURRENTS.

BY

Brown Ayres

The use of the telephone as an exceedingly sensitive galvanoscope in the Wheatstone bridge occurred naturally to many soon after the invention of the instrument. The possibility of such use was pointed out by myself,[1] among others, as early as 1877. The method has since been used by Kohlrausch and is known as Kohlrausch's method. Its special fitness for the determination of electrolytic resistances has made it useful in his hands. Its use for determinations of resistances of ordinary conductors has frequently been attempted, but as a rule is not satisfactory. The reason for its failure to give good results is not difficult to see. The oscillatory or pulsatory current produced by any form of circuit breaker is not a simple harmonic in character, but, broadly speaking, is of a character analogous to the air vibrations from a reed pipe—having a fundamental and harmonics.

When we attempt to balance a bridge in which a telephone is the indicating instrument, we find it impossible, as a general rule, to find any point of complete silence in the telephone. The cause of this is that the impedance for all the pulsations making up the complex current according to the principle of Fourier is not the same. If

$$I = \sqrt{R^2 + p^2 L^2}$$

where I is the impedance, R the conductor resistance, L the coefficient of self-induction and $p = 2\,\pi\,n$, n being the number of oscillations per second,—it is evident that for a real resistance balance we will still have an effect due to the term $p^2\,L^2$. The only way therefore to get silence in the telephone is either to have $L = 0$, or $p = 0$; that is, to have the resistances to be compared wound anti-inductively, or to use a steady current.

If we attempt to measure the resistance of a circuit having inductance, when we have balanced for the impedance of any harmonic the balance will not be perfect for the others. Hence a sound of somewhat different character will be heard in the telephone. For the measurement of liquids in tubes or short wires of small inductance the method can be used; but for ordinary purposes it is not satisfactory. If we could get a simple harmonic current, we could get a balance; but even then it would be the ratio of impedances that we had found, not the ratio of resistances.

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[1] *Journal of the Franklin Institute*, June, 1878.

TULANE UNIVERSITY, NEW ORLEANS, LA.

BRAKING STREET CARS ELECTRICALLY.

BY

Maurice Hooper

I HAVE read in THE ELECTRICAL ENGINEER of May 11 a description of a method of braking electric railway cars devised by Prof. S. H. Short. This speaks of an arrangement such that one motor overpowers the other, and, as I understand it, one motor, acting as a generator, tends to drive the other as a motor, and thus retards the car.

I am not familiar with the Short car wiring, but understand that the two series-wound motors are in parallel, having a separate reversing switch for each armature. With this method of wiring, where the armatures are not parallel independently from the fields, considering the car coasting down hill with the reversing switches set for a direction opposite to that of the car, is not the case that of two series dynamos in parallel and driven at equal speeds? In this case the machine building up first would reverse the other, and then the two would run as two series machines wired in series on short circuit, and would generate a tremendous current and reduce the speed of the car to a point where the resistance to the motion of the armature in the field balances the attraction of gravity, or other force propelling the car. With this, considering a car wired as I have assumed the Short cars are, it would be necessary only to reverse the car, when coasting down hill, to slacken its speed without the use of current from the line, or of brakes.

I have had a car on the West Chester, Pa., street railway equipped, for some time, with a switch on each platform to disconnect the trolley end of the car wiring from the trolley and connect it to the car ground. By doing this, and throwing the controlling switch as though to reverse the car, the car may be controlled on a down grade very easily. The motors build up rapidly and bring the car up rather abruptly, but not sufficiently so to endanger the gears, and not anything like the way it is done on reversing the motors, even when the latter is done through maximum resistance.

In the case of the Edison equipment, with the motors short-circuited, it is a case of two shunt dynamos connected in parallel, and having fields of such low resistance that they practically short-circuit the armatures. This arrangement of wiring, while it takes the place of a set of reserve brakes, costs but a few dollars to apply to a car. It requires a single-pole double-throw switch on each platform, with the lever connected to the "A" of the wiring and one point connected to the trolley and the other to ground. This switch takes the place of the ordinary cut-out switch.

While this method of braking is not to be recommended for ordinary use, as is no method that uses the gears, it has certain very decided advantages over any other. It is well known that where there is any tendency of the wheels to slide on the rails the best braking is that which comes nearest to making the wheels slide without doing so. The motors accomplish this automatically, as the instant the wheels slip the armatures cease revolving and there is no further tendency towards retardation. This is an especially valuable feature and makes it possible to descend safely, without sand, many grades that are otherwise extremely dangerous.

As we use the switch the motormen are not allowed to brake the car with it, except in case of absolute necessity. It should be tried at least once each day to see that it is in order. This may be done when the car is running at such a low speed as to bring very little strain on the gears. I have never known the method to fail and think it saves the second set of brakes on a car, which means that it saves money in first cost and in maintenance, as well as the inconvenience of the extra brake rods and other mechanism about the truck and platforms. The only surprising thing in connection with it is the fact that it has not come into common use before this.

STORAGE BATTERIES IN RAILWAY POWER STATIONS.

BY

W. M. Miner

"WHY not try it here?" are the concluding words of your recent editorial on storage batteries in central station work abroad. Yes, why not, and particularly in connection with electric railroads? Mr. W. Lee Church's excellent article in the same issue of the ENGINEER, on the requirements of the generating station of an electrical street road, shows clearly what a strain this important part of the plant is subjected to, on account of the rapid and extreme fluctuations of the current.

By the use of a storage battery of sufficient ampere capacity, in shunt with the generator we could use an engine and generator, whose rated capacity would be a little above the average requirements of the station, thereby working our engine at its greatest efficiency, and preventing those sudden changes from no work to more than the engine and generator were calculated to stand. When the demand of the feeder lines is *less* than the average output, then it goes to the storage battery; and when the demand is *more* than the average, the storage battery comes to the aid of the generator, keeping the supply to the feeders nearly constant, merely requiring the generator to work at its full capacity, the storage battery doing the rest. This would improve the running of the cars also, as ordinarily, when this heavy load comes on the generator it affects all the motors working at the time, lowering the potential quite perceptibly. I have seen lights in cars in which I was riding, dim to nearly, or quite, half their candle power, caused by the heavy drain on the line, due to the starting of several cars at about the same time, at other parts of the line. The storage battery would, in such cases, I believe, prevent this large drop in potential. As 500 volts is the usual potential for railway work, it would require about 250 storage cells in series; the space occupied might be considered an objection, but as they could be placed on shelves one above the other, the *floor* space would not be so excessive after all.

It is not my intention in this short article to go into details or figures, but to call the attention of electricians to what seems to me would be a useful adjunct to the generating station of street railways. I have used this method of supplying current to a motor where it was imperative that the motor should run absolutely steady and found it to work well, so that I have every reason to believe it would, in a certain measure, do the same for street car work.

A STUPENDOUS COLUMN OF WATER AT VIRGINIA CITY, NEV.

ALTOGETHER the most extraordinary water-power installation —so far as head is concerned—ever known has recently been made by the Pelton Water Wheel Co. in one of the famous Comstock mines at Virginia City, Nevada. The wheel is 36 in. diameter, made of a solid steel disc with the buckets riveted on to the periphery in a way to afford absolute security, and weighs, complete, 180 lbs.

It is running under a vertical head of 2,100 feet, equal to 911 lbs. pressure; 460 feet of this head is obtained from the pipe line of the Gold Hill Water Co., and the remaining 1,640 feet from the California and Con. Virginia shaft, down which the pipe line is run to the Sutro Tunnel level, where the power station is located and through which the water discharges after passing over the wheel. The wheel runs at 1,150 revolutions, with a peripheral speed of 10,804 feet per minute, or about 120 miles per hour.

The construction of the wheel amply provides for the centrifugal strain the velocity of the water gives it, running without load, when it would attain the enormous speed of 21,608 feet per minute, equal to about 240 miles per hour. A nozzle tip ½ in. diameter gives under above conditions 100 h. p. Every miner's inch of water, equal to a flow of 1.6 cubic feet per minute, gives 5 h. p., while 1 h. p. is given for every 2 lbs. of metal in the wheel. It is only by comparison that an idea can be obtained of the height of a column of water due to such pressure. It is more than four times as high as the Washington Monument and considerably more than twice the height of the Eiffel Tower. It is safe to say that no water wheel has ever before been operated under any such head, nor any such demonstration afforded of the velocity and power of water under such an extreme pressure.

The installation made by the Pelton Company some two years ago in the Chollar shaft on the Comstock lode is in some respects no less extraordinary. This consists of six 40 in. Pelton Wheels, which run under a vertical head of 1,680 feet, driving that number of electrical generators, the power from which is conveyed up the shaft to the Nevada Mill some 2,000 feet distant. These wheels only weigh 220 lbs. each, and with nozzle tips ⅝ of an inch diameter develop 125 h. p. each.

The water is first run over a Pelton wheel on the surface under 460 feet head, and is then carried down the shaft by a pipe to the Sutro Tunnel level, where the underground station is located, the power from the electrical generators being conveyed to the countershaft of the mill with which the surface wheel is connected, the two distinct forces working together in perfect harmony.

A most interesting illustration of the double use of water is here given, some 400 h. p. being produced in this way from what may be termed waste water. This station has now been running more than three years without interruption and practically without expense in the way of repairs, as well as without any appreciable loss of efficiency, affording a most striking example of the advantages of water power, both by direct application and electric transmission, as well as the reliability of such a plant under such extraordinary conditions.

RESISTANCE STANDARDS—THEIR MANUFACTURE AND ADJUSTMENT.[1]

BY ELMER G. WILLYOUNG.

THE standard of resistance, as generally known, is a length of wire of one kind or another, wound upon a spool, mounted in a convenient case to protect it from injury and moisture, and having its resistance at some given temperature definitely determined; a true standard also has its rate of variation of resistance for change of temperature accurately known. Sometimes one coil is mounted up alone and sometimes many coils of different values are put up in the same mounting.

In the manufacture of standards of resistance a great many qualities are required of the resistance wire which shall be used. It should have high specific resistance, and as small a temperature coefficient of resistance as possible; it must not change its resistance in time; it must not be oxidizable by the air or by the medium in which it may be enclosed; and it must be of a hardness suitable for handling in manufacture and adjustment without injury. The requirement of high specific resistance immediately compels us to reject copper, iron, aluminum, silver and all other pure metals except lead, antimony and bismuth. The softness, difficulty of working, and high temperature coefficient, as well as many other reasons, would throw these last three out of the account. The matter of temperature coefficient alone, in fact, would compel us to reject all pure metals since they all increase roughly about twenty-five per cent. in resistance between 0 and 100 C., except iron, which increases about forty per cent. We are, therefore, led to try alloys. Dr. Matthiessen, chairman of the sub-committee (of the Committee on Electrical Standards of the British Association), from 1862–65, having in charge the investigation of the properties of wires with reference to the selection of a suitable one to be used in the standard of resistance, decided upon by the British Association and now known as the B. A. ohm, and examined very exhaustively a large number of wires, among which were pure iron, silver, copper, thallium and other metals, and a great many alloys; he finally concluded that silver alloyed with 33.4 per cent. of platinum was the best alloy obtainable. This alloy, known as platinum silver, is still used by English makers; it has a specific resistance of twenty-four microhms and a per cent. variation per degree C. of $\frac{31}{100}$. In selecting this alloy we see that the requirements of high specific resistance and low temperature coefficient have both been observed, the resistance of platinum silver being about sixteen times that of copper and its temperature coefficient less than $\frac{1}{100}$ that of copper.

With reference to the constancy of resistance in wires it may be well to mention that many metals and alloys seem to alter in electrical resistance with time, or on being subjected to change of temperature. In an investigation carried on by J. Bergmann, a German electrician, in the latter part of 1889, he reports that, after raising to and maintaining at 300° C. for one hour and then cooling, the resistance of several substances changed as follows:

	Per cent.
Copper decreased	2.4
Aluminum "	5.0
Magnesium "	6.8
Zinc "	2.4
German-silver increased	$\frac{2}{10}$

It is almost self-evident that the resistance of a metal or alloy is a function of its density; hence, all causes tending to change the density of the resistance metal will also tend to change its resistance. It is quite reasonable to expect, therefore, that an increase of resistance should be observed after a wire is wound upon a spool. A wire wound upon a spool not over eight times its own diameter will increase from one-half to two per cent. in resistance; a part of this increased resistance is due to the increased hardness caused on the inside of each turn, by the bending stress, and hence gradually falls away as the wire slowly anneals. For this reason, it is unsafe to send out a resistance standard as correct until several months have elapsed after winding.

According to Drs. Feussner and S. Lindeck, in *Zeitschrift für Instrumentenkunde*, February, 1891, an alloy composed of seventy per cent. copper and thirty per cent. manganese had a resistance of about five times that of German silver and a temperature coefficient of but $\frac{4}{1000}$ per cent. per degree Centigrade, while an alloy of seventy-three per cent. copper, three per cent. nickel, and twenty-four per cent. manganese had a specific resistance a little less than three times that of German silver, and a *negative* temperature coefficient of $\frac{3}{1000}$ per cent. Hence we see that it ought to be entirely possible to obtain a wire having a zero coefficient, *i. e.*, not changing resistance at all for change of temperature by properly combining the constituent metals of this alloy.

A strictly standard resistance is, according to the practice of the best makers, adjusted to anything within from $\frac{1}{10}$ to $\frac{1}{100}$ per cent. of absolute accuracy. A *single* coil would not be considered a "standard coil" unless it were accurate within from $_{50}$ to $\frac{1}{100}$ per cent. of absolute accuracy. To obtain this high accuracy of adjustment it is easily seen that very exact methods of measurement must be employed; should we attempt to measure an inch within this limit of error, the error could not be over $\frac{1}{10000}$ inch, an exceedingly small quantity. Various methods have been suggested and employed by different parties at different times. Such an apparatus designed by Prof. Fleeming Jenkin, was used somewhat by the British Association Committee in 1862. A complete description of this method and convenient apparatus will be found on p. 38 of *Reports of Electrical Standards*, published by Spon.

I have here a piece of apparatus first designed several years ago during my student days. It is a modification of an arrangement devised by Prof. S. P. Thompson, and described in *Stewart & Gee*, 2d vol., p. 160. The one I have here was first suggested to me by Prof. H. S. Carhart, of Michigan University, and has since been somewhat modified by myself. If we take an ordinary slide wire bridge having four openings for coils at the back and (the slide wire being in front) fill these spaces, beginning at the left, with coils designated P R_1 R_2 and Q, respectively, connect the battery from between P and R_1 to between R_2 and Q, and the galvanometer from between R_1 and R_2 to a point on the slide wire, we have substantially the method which is known as the Cary-Foster method. Designating the resistance of copper connector at the left by r_1 and of copper connector at the right by r_2 and letting P be the resistance of unit division of the wire.

$$\frac{R_1}{R_2}=\frac{P+r_1+X_1\,\rho}{Q+r_2+(L-X_1)\,\rho} \tag{1}$$

where X is the reading on the bridge wire and L the total number of divisions. Reverse the position of P and Q and we have

$$\frac{R_1}{R_2}=\frac{Q+r+X_2\,\rho}{P+r_2+(L-X_2)\rho} \tag{2}$$

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[1] Abstract of a paper read before the Electrical Section of the Franklin Institute.

From (1) we have

$$\frac{R_1}{R_1 + R_2} = \frac{P + r_1 + X_1 \rho}{P + Q + r_1 + r_2 + L\rho} \qquad (3)$$

and from (2) we have

$$\frac{R_1}{R_1 + R_2} = \frac{Q + r_1 + X_2 \rho}{P + Q + r_1 + r_2 + L\rho} \qquad (4)$$

From (3) and (4) we get

$$Q + r_1 + X_2 \rho = P + r_1 + X_1 \rho$$
$$Q - P = \rho (X_1 - X_2),$$

which is an expression independent of the resistance of the end pieces of the bridge, being merely the resistance of that portion of the wire over which we must move in obtaining our two balances. Thompson's device is merely for quickly and conveniently interchanging coils P and Q; with it we must change the position of four copper connectors in four mercury cups; this is tedious and increases the danger of a change of temperature between the adjustments. The modification which I have here has reduced these changes to two which can be made almost instantly. With this device and a carefully calibrated bridge wire it is an extremely simple matter to attain an accuracy of $\frac{1}{100}$ per cent., while much higher percentages of accuracy may be gotten with care. Of course, in this method the coils P and Q must be at a definitely known temperature which shall not change during the taking of the two readings; hence, the two coils are placed in well-stirred water or oil baths. The other coils R and S are wound together and left in the open air as, if they change at all, they will probably change about equally and the result be of no appreciable importance. This device is also the best thing to use in determining temperature coefficients of wires; a length of wire is wound up on a spool, immersed in oil at a definite temperature and compared with a standard. The temperature of the oil is then raised and the resistance of the wire again determined; knowing the difference of temperature and the change of resistance the temperature coefficient follows.

NORTH CAROLINA'S LATEST ELECTRIC RAILWAY.

About the first small town in the United States to attempt an electric railway was Asheville, N. C. Hardly had the successful opening of the Richmond, Va., electric railway been accomplished by the Sprague Company than the work of constructing a road over a route fully as difficult as that in Richmond was begun and when finished demonstrated the ability of the electric system to earn a living in a town of 10,000 inhabitants. The success of this road was widely felt through the Southeastern States, and in North Carolina particularly. There is probably no state in the Union that cannot outrank North Carolina in the point of large towns. Only five reach as high as 15,000 inhabitants, but in four of these, Asheville, Winston, Charlotte and Raleigh, are electric railways in successful operation, and on May 1st, the latest line was opened in Wilmington, the principal town of the State, with a population of 23,000 inhabitants. For four years past there has been in operation the Wilmington Street Railway Company, operating seven small horse cars over about four miles of track; and in December last this line was purchased by a syndicate, several of whom had been instrumental in the organization of the Asheville and Winston roads. In the middle of February the horse cars were withdrawn, and the work of rebuilding the track, building the power station and the overhead lines was begun.

On the principal street the old rail was taken up and a mile of Lewis & Fowler girder rail was laid, while outside of that street the old track was resurfaced and the number of cross-ties doubled. The contract for reconstructing the roadbed and building the overhead lines was let to J. G. White & Co. of 29 Broadway, New York, and was by them completed by April 15. Situated as Wilmington is, in the heart of the yellow pine and juniper country, wooden poles were of course employed, and a neater looking piece of line work cannot be found. The building containing the power plant, car shed and company's offices was designed by Mr. Clarence S. Luce of 181 Broadway, New York, and carried out by Valentino Brown & Co. of Brunswick, Ga., and is a model of convenience and economical construction. The main building is of brick, and the whole of the lower floor 68 x 45 feet is reserved for engines and dynamos. At present a temporary partition is run across one end forming the engineer's storeroom and superintendent's office. The rest of the room leaves ample space for the accommodation of five 15 x 16 foot high speed engines and their dynamos. Should a sixth ever be required, the wooden partition can be taken down and the superintendent's office be moved into the ample space on the second floor. The boiler-room and coal bin immediately adjoining the engine room is also of brick. The former is of sufficient size to accommodate three horizontal return tubular boilers 66 inches x 16 feet; and the latter will hold a cargo of from 450 to 500 tons of coal. Surrounding the engine and boiler rooms is the car shed, with track room for twelve cars, and a freight track for the delivery of coal by rail.

In a Southern climate much attention to ventilation is required, and in this plant excellent results have been obtained. Located on a corner lot on the river front, the engine-room was placed in the corner fronting both streets so that windows could be placed to catch the air on both streets and from the end facing the car shed. The floor was raised five feet above the ground line, and ample air openings were allowed. Through the second story and roof is carried an air shaft 9 x 16 feet to a cupola which creates a strong upward draught. Around this air shaft are located the company's offices, which are particularly bright and airy, and which owe much of their ventilation to it. The steam plant so far installed consists of two 100 h. p. horizontal return tubular boilers 66 x 16 inches; two 15 x 16 inch Ball high speed engines; one Goubert feed-water heater and one Davidson 300 h. p. independent air pump and condenser. The condenser and heater are so connected that they may be used together or separately, or the exhaust may be thrown directly into the air. This plant was installed by the Ball Engine Co. on the general lines laid down in the design of the building, and is a model plant for roads of ordinary size. In the arrangement of the whole much thought has been given to the adaptability of the present installation to future growth.

The supply of water for the condenser is obtained from the Cape Fear River. The boilers are ordinarly fed from the hot well, but for use when the condenser may not be in operation a 3-inch pipe leads to the river and connection is also made with the city mains. From either of these sources of supply the boilers can be fed either through or around the heater by either the feed pump or injector. The station electrical equipment consists of two Edison 100 K. W. railway generators. The car equipment of six open cars and two 16-foot closed cars built by Lewis & Fowler and equipped with two 15 h. p. S. R.S. Thomson-Houston motors. Of the eleven horse cars purchased with the road, four open cars are being overhauled and repainted for use as trailers.

The original mileage of the horse car line has been increased by a mile of new line to a beautiful live oak grove which has been purchased as a park; and, in addition, the company, under its exclusive franchises, has constructed along the wharf front a steam railway, which when completed will connect all the six railways entering Wilmington with all the wharves, warehouses and principal mills of the city. This line is to be operated by a compound steam motor built by the Baldwin Locomotive Works.

Literature.

A Dictionary of Electrical Words, Terms and Phrases. By Edwin J. Houston, A. M. Second edition, rewritten and greatly enlarged. *New York*, 1892. The W. J. Johnston Co., Limited. 562 pp. 7 x 9½ inches. Price $5.00.

The issuance of the first edition of Prof. Houston's dictionary, something over two years since, for the first time placed in the hands of the English reader a work of reference, the need for which was so crying that it is not to be wondered at that the first edition was soon exhausted. With the great demand thus manifested it is a matter for particular congratulation, that the author decided to discard the original plates and to present us with practically a new work. The difference between the old and the new edition can be best realized when it is stated that there are no less than five thousand distinct titles, for which definitions are given, while the cross-references in this edition are copious, and we had almost said in some cases too much so.

At the time that the first edition was published, a large number of newly coined expressions and terms, although they had been used by a few writers, were, it appears, not deemed to have been sufficiently recognized by general usage to warrant the author in inserting them in the work, but we are glad to note that these omissions have now been fully supplied and that the work to-day presents probably as complete an index of the terms of the science and art of electricity as could be well got together.

As regards the definitions themselves they are in the main admirable, considering especially the necessarily limited space which could be devoted to each and still bring the book within reasonable compass; but in glancing over the work we have noticed a few slips to which we would draw attention, not in the spirit of criticism but of friendly suggestion. It might appear to be a useless refinement to have added the pronunciation of the electrical terms, especially those of recent origin, which we notice are pronounced in various ways. Even the word dynamo, one in such common use, is still frequently heard spoken with the accent on the first syllable and again on the second.

The author has frequently, it is true, drawn his definitions from the works of well-known authors, but we think the value of the book could have been increased by quotations in many instances from more than one author, as even in electrical science words have shades of meaning which those who refer to a work of this kind ought to have their attention drawn to. In many instances also a direct quotation would have added largely to the understanding of the definition as given. In some instances we note also the lack of more general information. Thus in defining the term "Electric Current Teaser," the fact that this arrangement, employed by Brush, effected the compounding of the dynamo is not set forth, so that one not versed in the earlier history of the art would fail to obtain a complete comprehension of the term.

While the illustrations in general are good, we note a number of antiquated cuts which represent apparatus that could hardly be called "up to date," and in one instance we notice the employment of an engraving of a ceiling block under the head of branch block. It might be contended that a ceiling block is a branch block in one sense of the term, but the workers in the art would hardly so construe it. We have also noticed in some cases omissions, although not of a serious nature; thus under the head of "Electro-Magnetic Brake" the author has omitted to mention the method of braking by converting a motor into a dynamo, a method now coming into more general use in railway practice, and which is likely to extend in the future. We notice also that the author maintains his original opinion as to the *de jure* inventor of the telephone, as he still accords to Reis the authorship of that instrument. In the case also of the microphone the invention is credited to Prof. Hughes, and the author states that the "forms of transmitting telephones, invented by Reis, Edison, Blake, Berliner and others, are in reality varieties of microphones." We question the advisability, or indeed the right of the author to make categorical statements of this nature in a work of this kind, where there is, or has been, a question involving the authorship of certain electrical devices. We believe, in fact, that it detracts from the value of the work, which should be as far as possible an impartial statement of facts, rather than of opinions. The author has occasionally also thrown in a word, the relevancy of whose position in electrical work is not clear to us, for instance the word "Bioplasm."

Completeness in a work of this kind can hardly be hoped for, and the few suggestions we have made above are offered as an encouragement in the work which Prof. Houston has so successfully undertaken. No one appreciates more than ourselves the tremendous amount of labor involved in the preparation and revision of a work of this kind, and we can only offer our congratulations to Prof. Houston for the admirable manner in which he has succeeded in bringing such a large mass of information within so small a compass.

Letters to the Editor.

Notice to Correspondents.

We do not hold ourselves responsible for the opinions of our correspondents.
Anonymous communications cannot be noticed.
The Editor respectfully requests that all communications may be drawn up as briefly and as much to the point as possible.
In order to facilitate reference, correspondents, when referring to any letter previously inserted, will oblige by mentioning the page on which it appears.
Sketches and drawings for illustrations should be on separate pieces of paper.
All communications should be addressed EDITOR OF THE ELECTRICAL ENGINEER, *203 Broadway, New York city.*

CONCERNING THE "KELVIN."

THE ENGLISH BOARD OF TRADE UNIT is reported to be named the "Kelvin" after the title assumed by Sir William Thomson on entering the peerage. There is a sort of unwritten law that public statues and portraits of people on postage stamps and currency (excepting, as Mr. Thomas D. Lockwood would, no doubt, hasten to remind us, those of Royalty) shall be reserved as posthumous honors. It would be better if new scientific nomenclature were similarly restricted, if only to keep it free from the meddling interference of the British snob.

Lord Kelvin's reputation has been made under the name of Thomson; and as the British Constitution does not contemplate the ennobling of scientific instruments and discoveries, the Thomson galvanometer, the Thomson syphon recorder, the Thomson sounding apparatus, the Thomson compass, the Thomson electrometer, the Thomson effect, and other results of his genius, will continue so universally to be known as such, that it is doubtful if any one (Mr. Lockwood always excepted) will even think of them as the Kelvin galvanometer, the Kelvin recorder, etc., etc. If a unit was to be named after Lord Kelvin, (and the merit of the act is indisputable), what possible objection could there have been to designating it as the "Thomson?" The word is just as short and just as mellifluous as the "Kelvin," and it perpetuates the actual name of the philosopher, and not a mere appendage which is associated with nothing in his career except, perhaps, that amiable failing which has led more than one eminent man to imagine that a title honors him, and not he, the title.

Of course, posterity, in the end, settles these things. It would have preserved the patronymics of Tennyson and Macaulay even if they had not wisely done so themselves. It has refused to sink Pitt in Chatham, Bacon in St. Albans, or even D'Israeli in Beaconsfield. The honors of nomenclature, as witness the "Weber," are sometimes evanescent; and perhaps the "Kelvin" will live no longer than the "Mho" and the "Mac." The "Henry" and the "Franklin" belong to the American Nazareth; and Galvani and Beccaria, and Ritter and Guericke, are likewise to the insular taste open to the objection of being foreigners. But think of Englishmen, in this nineteenth century, passing over Gilbert, and Boyle, and Gray, and Sturgeon, and Davy, and Green, and Siemens, to call a unit after an obscure locality in the "knuckle end of creation," without the slightest claim to notice other than that a peer has chosen its name as the tag to his coronet!

PARK BENJAMIN.

NEW YORK CITY, May 25, 1892.

SHORT'S METHOD OF BRAKING ELECTRIC CARS.

IN THE ELECTRICAL ENGINEER, of May 11, 1892, there appeared an article under the heading of "Short's Method of Stopping Electric Locomotives." I would like to call attention to this as another of the frequent cases in which two inventors strike upon the same idea independently of each other.

The identical arrangement as set forth in the Short article was invented by Mr. Edward H. Johnson, and put in practical operation upon an experimental track in this city in the early part of 1891. The car was fitted with two motors, and a special switch which permitted the brake arrangement to be applied at will.

With this arrangement it was found possible to stop a car in almost its own length whilst running full speed down a very steep incline. As Mr. Johnson's invention was examined by many experts and others who tested the practical working of the method at the time, it leaves, I think, no doubt as to the priority of invention.

Yours very truly,

GEORGE A. SCOTT.

NEW YORK CITY, May 23, 1892.

CONCERT TELEPHONES.

IN your last issue is an article by Herbert Laws Webb, on Long-Distance Telephony. He speaks of a musical performance at New York being heard at Saratoga all over the room by means of a single loud-speaking receiver. Will you kindly inform me how this receiver differs from the ordinary Bell form of receiver and why it is not in more common use?

GEO. A. BAKER.

LEAVENWORTH, KAN.

For these performances a special form of double-pole receiver—much too cumbersome for ordinary use—is employed, a large funnel or resonator being attached to magnify and concentrate the effect. It is well known that musical sounds are always heard much more clearly over the telephone than spoken speech. The ordinary Bell receiver is so sensitive that there is no need of providing a loud-speaking receiver for ordinary service. Besides, a loud-speaking telephone would frequently divulge information to others than those for whom it is intended.—EDS. E. E.

Society and Club Notes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the May meeting of the council of the Institute, the following gentlemen were admitted to associate membership:

Beals, Pascal P., electrical contractor and agent for the Waddell-Entz Electric Co., 50 Terrace, Buffalo, N. Y.
Berthold, Victor M., with T. D. Lockwood in patent department of American Bell Telephone Co., 16 Upton street, Cambridgeport, Mass.
Bosson, Frederick N., electrician, Calumet and Hecla Mining Co., Calumet, Mich.
Floy, Henry, graduate student in electrical engineering, Cornell University, Barnes Hall, Ithaca, N. Y.
Gross, S. Ross, electrician, Tennessee Coal, Iron & Railroad Co., Ensley, Ala.
Little, Franklin P., manager, F. P. Little & Co., 141 East Seneca street, Buffalo, N. Y.
McRae, Austin Lee, professor of physics, Missouri School of Mines, Rolla, Mo.
Perry, Nelson W., E. M., editor *Electricity*, 6 Park Place, New York City.
Shaw, Edwin C., general superintendent, Thomson-Houston Electric Light and Power Co., 40 Court street, Buffalo, N. Y.
Verley, Horace S. L., with Dr. Wm. E. Geyer, as laboratory assistant, Stevens Institute, Hoboken, N. J.

NEW YORK ELECTRIC CLUB.

THE board of managers of the New York Electric Club, at their monthly meeting, held at the Club House, 17 East Twenty-second street, Thursday, May 19, 1892, elected the following 22 new members: *Active.*—Mortimer M. Hayden, John F. Zebley, E. C. Brown.

Associate.—Geo. Urban, Jr., D. T. Everts, S. L. Phillips, C. I, Hills, J. A. Seymour, A. J. Belden, Chas. J. Mayer, J. Calisch, R. J. Getz, C. H. McIntire, G. F. Wheeler, F. P. Little, John E. McIntosh, Howard H. Crowell, E. T. Pardee, Samuel G. Booker, Chas. R. Lloyd, C. S. Knight, D. F. Urquhart.

A very successful entertainment was given at the club house on Friday evening, May 27, with professional talent. The chief contributions were made by the Brothers Perry, who gave a musical melange with hand bells, musical glasses, sleigh bells, etc.; and the Mendelssohn Glee Club Quartette, composed of Messrs. Prime, Marson, Irving and Hall, who also sang various solos and duets. After the concert, Treasurer Phelps, at the request of President Insull, made an interesting statement as to what had been accomplished in the way of straightening out the club's finances, and then followed a collation served by Mr. Reynolds, the steward of the club.

NATIONAL TRADE PRESS ASSOCIATION.

SOME weeks since a movement was inaugurated in Chicago by the representatives in that city of leading trade and class newspapers, having for its object the perfecting of an association for social intercourse, and for the betterment, in various ways, of the business interests of the advertising solicitors connected with the technical press. Several meetings have been held, and Thursday, May 19, the members met at luncheon and adopted a constitution and by-laws and elected officers for an organization, to be known as the National Trade Press Association.

The representatives of nearly every prominent trade or class newspaper published in Chicago or represented there by a business office have already signed the roll of membership, or have expressed a willingness to do so, and the building up of a strong social organization is confidently predicted. Until permanent quarters are secured, meetings will be held on the first Tuesday of each month at some prominent hotel or club room, when a lunch will be served, papers read, and the regular business of the club transacted. The following is a list of the officers elected for the ensuing year: President, W. A. Carroll, *Scientific American;* vice-presidents, Gilbert C. McDuff, *Johnston's Directory*; J. F. Connor, *Electricity;* Clarence P. Day, *Manufacturers' Record;* D. H. Ogden, *Western Electrician;* treasurer, M. J. Bulkley, *Electrical Review;* secretary, W. Forman Collins, THE ELECTRICAL ENGINEER; directors, J. P. Tuttle, *Western Brewer;* J. W. Dickerson, *Street Railway Journal;* Jno. C. Burnell, *Brewers' Journal.* Such an organization of local representatives of class journals may easily be made very useful as well as agreeable to its members. The title chosen does not seem felicitous as indicating the nature of the association, which can hardly claim to be a national body.

THE NEW ENGLAND ELECTRIC CLUB.

THE NEW ENGLAND ELECTRIC CLUB, which was formed some months ago and which has interested a large number of electrical men throughout New England, formally opened its club house in Boston, last Wednesday. The house is situated at No. 14 Bosworth street and is very centrally located, being within easy reach of all the hotels and theatres. The whole house will be occupied by the club members and it is the intention to keep the first floor for the reception room and the dining room. The front room is given up for reception purposes and as a general room for conversation and reading. The back room on this floor is the dining room and is at present connected with a neighboring restaurant so that members can be served with meals at all times of the day or night. On the second floor is the billiard room, one or two private dining rooms, a kitchen and a wine room. This kitchen will not be used at present but as the club grows larger and stronger it is the intention of the managers to run their own kitchen. The entire third floor is given up to sleeping rooms, of which there are three for the accommodation principally of out of town members who will always be able to find a comfortable room at their disposal at a very moderate price and will feel more at home than by going to hotels. The club house is fitted up with electric lights and last Wednesday evening presented a most attractive appearance. Invitations had been sent to every one interested in electrical business in New England and elsewhere and a very large company assembled to do justice to the entertainment which was provided. In the dining room a récherché cold lunch was provided and a very full and flowing punch bowl occupied a prominent position in the centre of the table. Music was also provided by the Everett Banjo, Mandolin and Guitar Club, who during the evening rendered some very pleasing pieces. Judging from the hearty expressions of the large number who were present on the occasion of the opening night it is safe to predict that the club will be successful, and we hope that with good business management the New England Electric Club will soon take a prominent position in this city of clubs. It is interesting to note that the club house has been furnished largely by the generosity of a number of Boston firms and many of the fixtures have been specially donated. The club started with a membership of two hundred, the majority of whom are paid up members, and if the good will shown by the gentlemen who gathered together on Wednesday evening can be taken as criterion we feel that the interest in the club will grow stronger and stronger and that the membership will soon be increased to three hundred.

The presidency of the club is now filled by Mr. C. S. Knowles, who is well known to the electrical trade as a manufacturer of rubber goods used in the manufacture of electrical apparatus. Mr. Ferdinand K. Wyman who was the first president was obliged to resign on account of his health. The remaining officers are the same as elected at the meeting in Jannary, and are: Vice-President, Mr. E. A. Record, New England manager for the Vacuum Oil Co.; treasurer, Mr. A. O. Smith, treasurer of the Eastern Electrical Supply Co.; secretary, Mr. Lynn M. Hays, night city editor of the *Boston Globe;* directors, Mr. Maybin W. Brown, president of the Eastern Electrical Supply Co.; Mr. Elmer P. Morris, manager of the railroad supply department Thomson-Houston Co.; Mr. Charles C. Pierce, manager of the railroad department of the Edison Co.; Mr. E. R. Tilton, with Pettingell Andrews Co.; Edward W. Sawyer, of Sawyer, Walbridge and Briggs. Great credit is due these gentlemen for the work which they accomplished in getting this club house ready so soon and we can cordially recommend it to every electrical man in New England and elsewhere who desires to have some place where he can meet congenial spirits. The president, Mr. C. S. Knowles is a successful business man of this city and brings with him a large business experience and influence, and has given a large part of the time during the last few months to make the club a success. The other officers and directors of the club are all successful business men of Boston and their names are sufficient to assure that degree of success which the club deserves, and which we hope for and anticipate.

THE INSTITUTE MEETING IN CHICAGO.

ALL the preliminary arrangements for the meeting of the American Institute of Electrical Engineers at Chicago on June 6, 7 and 8 have now been made, and there is every promise of a most successful meeting. Several interesting papers have been added to the programme already published, and over 75 members from all parts of the country have already signified their intention to be present. The Chicago Electric Club has also extended a generous welcome, and will entertain the Institute. The new club quarters will be opened on June 6, and that evening President Sprague will deliver at the club, by invitation, his inaugural address, his subject being: "Coming Developments of the Electric Railway." The New York contingent will leave by special car over the New York Central at midday on Saturday, June 4, arriving in Chicago Sunday afternoon. During the meeting, special trips will be made to the Pullman Works and the World's Fair grounds.

"FROM CHICAGO TO ST. LOUIS BY ELECTRIC EXPRESS."

THE above is the title of a very interesting paper which is to be read at the New York Electric Club on June 2 at 8 p. m. by Dr. Wellington Adams. It will deal with the engineering and commercial problems involved in the proposed high speed electric road between Chicago and St. Louis, and will be illustrated by lantern slides. The subject is of the greatest importance and will no doubt draw a large audience. Dr. Adams has made a specialty of this problem for some time past.

Personal.

MR. SAMUEL INSULL.

THAT the personnel of the executive department of the new General Electric Company is not yet quite settled is made evident by the fact that Mr. Samuel Insull who was but recently elected to the second vice-presidency has already resigned that important position to assume the presidency of the Chicago Edison Company, to which he was elected on Thursday last. It is understood that this will necessitate his removal to Chicago next July, and that he is already taking steps to resign various other offices that from time to time have been loaded upon him. That Mr. Insull should leave New York is a matter of deepest regret to his friends, but they are glad to see his high quality of merit appreciated in Chicago, a city that is always open-hearted to young men of talent. Mr. Insull is still a very young man, yet his record of faithful devotion to Mr. Edison as private secretary, then as the manager of the Edison Schenectady Works, and lately as the executive officer in charge of all the enormous Edison light and power manufacturing is one that he will always be able to take infinite pride in.

The Chicago Edison Company is an organization of wealthy Chicago merchants and bankers, and bids fair soon to be the largest local lighting company in the world. Its capital is $1,000,000 and the first step in increasing it is to $1,500,000, while it is about to build a huge new station whose ultimate capacity, it is said, is likely to be 50,000 or 60,000 h. p. Mr. J. W. Doane is vice-president of the company and Mr. F. S. Gorton, secretary and treasurer.

Prof. George Forbes since his arrival in New York has found his time very fully occupied, the opportunity having been seized by several capitalists and others to consult him with regard to proposed new enterprises. He has recently visited Niagara Falls at the request of the Cataract Construction Co., for whom he is acting in the capacity of consulting engineer in their enormous power transmission project, and has, it is understood, been retained also by the Calumet & Hecla Mining Co. as consulting engineer for their proposed utilization of about 2,000 h. p. in a transmission of several miles in their mines, for the various purposes of ventilation, pumping, drills, haulage, lighting, etc. These and other engagements are expected to detain Prof. Forbes longer in this country than he had at first intended to stop on this trip.

Reports of Companies.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.

Owing to an error and some confusion in the figures from which the abstract of the Westinghouse Company's report was prepared for The Electrical Engineer of last week, the reduction of indebtedness was made to appear $100,000 less than it was in fact. Our source of information gave the amount owing on accounts payable January 1, 1891, as $622,469.51, and the amount March 31, as $266,973.19. The official copy of the report just received gives $722,469.51 for January, 1891—showing a reduction in accounts payable of $455,496.32, instead of $355,496.32; making the entire reduction of indebtedness $3,515,334.80.

The name of N. W. Bumsted should be substituted for that of Chas. Fairchild in the new board of directors as printed in our issue of May 25.

The officers elected by the new board are as follows: Chairman, Brayton Ives; president, Geo. Westinghouse, Jr.; first vice-president and general manager, Lemuel Bannister; second vice-president, G. W. Hebard; assistant general manager, W. F. Zimmerman; secretary and attorney, Chas. A. Terry; treasurer, Ph. Ferd. Kobbe; general agent and assistant treasurer, W. C. Clark; auditor, F. H. Ketchum.

NEW ENGLAND NOTES.

The Combination Car Company, of Boston, issued a number of invitations to a large number of street railway superintendents and friends to attend on Saturday, the 14th inst., the inaugural trip of their combination car, which has been put in regular service on the road of the Newton and Waltham Street Railway, and will hereafter make regular trips between these two towns. The party was in charge of Mr. Gilman B. Bolton, treasurer and general manager, and was a marked success in every way. This car, as is well known, can be used either as an open summer car, or a closed winter car, and its many points of superiority were clearly shown on the trip. The passenger sits facing the direction in which he is going, as in a steam car, and the whole car can be instantly changed from a closed car to an open car at will, or *vice versa*. The advantage of this must be apparent to every railroad man, as it entirely eliminates the necessity of having two sets of car bodies, one set of which must be idle during half the year, and the necessity of making expensive changes from time to time as the seasons change. At Waltham, a very recherché luncheon was provided, and a most pleasant day was spent.

The Germania Electric Company, of Boston, whose factory is at Marlborough, Mass., are about to change their offices from the Exchange Building, Boston, to 620 Atlantic avenue, and will hereafter occupy rooms 46 and 47 in that building. Dr. F. A. C. Perrine, formerly of the John A. Roebling's Sons Company, has become identified with this company as its treasurer, and will take charge of the management of the business. Dr. Perrine is well known to the electrical trade all over the country, and will be an important acquisition to the company. The general business of the Germania Company is extremely good, and they have large orders for lamps on hand. With their first-class facilities for manufacture at Marlborough, the Germania Company ought to do a large business, second to none in New England.

H. N. Bates & Co., of Boston, are at present engaged in installing the complete shafting equipment for the new central station of the Haverhill Electric Light Co., at Haverhill, Mass. This contract embraces shafting, pulleys, clutches and all necessary fittings. They have also received the order for the shafting, pulleys, clutches, etc., for the Electric Light and Power Department of the Upper Appomattox Company, Petersburg, Va. They have also got the contract for the whole shafting equipment of the Little Falls Electric Light Company, Little Falls, N. Y. Messrs. Bates & Co. are making a specialty of the question of shafting for electric light and power work, and are particularly well equipped for first-class work. They have also a number of special devices which are peculiarly useful in central stations, and which are all illustrated in the handsome catalogue which they recently compiled.

The Jarvis Engineering Company, of Boston, have just sold to the Consolidated Electric Light Company, of Portland, Me., five 100 h. p. compound condensing Armington & Sims engines of the horizontal type. The Jarvis Company are also now prepared to give estimates and furnish promptly the Wheelock coil heater, for which, we announced recently, they have become agents in New England. These heaters have recently been perfected, and are peculiarly adapted for electric plants, and can now be procured in any size at very short notice.

The Shawmut Fuse Wire Company, of Boston, who make a specialty of manufacturing fuse wire, tested by the Massachusetts Electrical Engineering Company, are in receipt of some very large orders for their product. Experience has shown that a tested fuse wire is absolutely indispensable in modern electric practice, and more and more electric companies are adopting it exclusively. The tag upon which is the name of the Massachusetts Company, is sufficient guarantee of its absolute reliability.

The Page Belting Company, of Concord, N. H., have made the following sales of their Eureka dynamo belt for electrical purposes: Two to Galveston, Texas; one to Chattanooga, Tenn.; two to Roanoke, Va.; one to Seymour, Conn.; one to Boston; nine belts to Brooklyn City R. R. Co., Brooklyn, N. Y.; four to United States Electric Light Co., Washington, D. C.; two to Staten Island Light, Heat and Power Co., Port Richmond, N. Y.; three to the Prudential Insurance Co., Newark, N. J.

The Boston Electric Light Company will commence work, shortly, on the rebuilding of the Stanhope streeet station, which was burned down a few months ago. The building will occupy just the same area as before, but will be more modern in its internal arrangements. The station, when complete, will have a total capacity of about 3,000 h. p. in dynamos and generators.

BALTIMORE NOTES.

The Automatic Switch Co., of No. 8 Keyser Building, has received the following letter from one of the first users of its new Whittingham automatic motor starter. The motor upon which this new service is operating is a 10 K. W. 110-volt Wenstrom, and is used for running a large paint mill, frequently drawing 90 amperes, for 14 hours at a time. The circuit upon which it is operated is subject to many stoppages during the day, and formerly the returning current after each stoppage would blow the fuse before the resistance could be turned in by hand. With the automatic motor starter now in use, the returning current starts the motor without damage, and without the least attention.

> Hershberg Hollander & Co., Importers, Jobbers and Manufacturers of Paints and Painters' and Artists' Materials, 106, 108 and 110 West Pratt Street and 23 West Lexington Street, Baltimore, Md., May 12, 1892.
>
> Automatic Switch Co., No. 8 Keyser Building, Baltimore, Md.
>
> Gentlemen: We take great pleasure in stating that after a trial of six months with your Automatic Motor Starter attached to our 12 h. p. Wenstrom Electric Motor, we are very much pleased. We have found it to be quite valuable, and deem it almost indispensable, and feel quite sure every one using the electric current for power, will find it a valuable acquisition. Having tried other switches, we find that the service we are using at present is decidedly the best, and consider it a perfect piece of mechanism. We wish you great success in the sale of your motor starter, and if we can be of any service to you in showing the working of said motor starter, then you are at liberty to send interested parties to our factory, so that they can fully satisfy thomselves.
>
> Very respectfully,
> (Signed) Hershberg, Hollander & Co.

The Williams Engine Works, 447 North street, are very busy now building engines. Orders are coming in and they are compelled to work at night. They are contracting with another shop to take hold of some of the work. They are building yacht engines, standard steam engines and very high speed engines for direct connection to dynamos. These engines are growing in popularity. With modern tools, advanced ideas and the experience of the past as a guide the builders of this engine are pushing to a leading position. Samuel T. Williams is proprietor of the works.

Mr. P. C. Burns, of Peru, Ind., manager of the Peru Porcelain Works, was a recent New York visitor. Mr. Burns reports excellent business with his company. There is scarcely anything in electric specialties and battery outfits that this company do not manufacture.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 17, 1892.

Alarms and Signals :—

Time-Call, J. James and J. Jones, Jr., 474,835. Filed July 31, 1891.
An electric annunciator for the use of hotels, etc.

Signaling Apparatus, B. J. Noyes, 474,852. Filed Sept. 17, 1889.
Employs a circuit changer connected with the signal transmitters to cut in, or render inoperative, the audible alarm.

Signaling Apparatus, B. J. Noyes, 474,853. Filed Sept. 17, 1889.
Similar in its object to No. 474,852.

Hotel-Call System, G. P. Greene, 474,907. Filed Oct. 31, 1891.
Provides means whereby each guest may indicate different services required by means of an annunciator in a hotel office.

System of Signaling, H. A. Chase, 474,945. Filed Dec. 18, 1891.
Provides means whereby the signal is indicated by two different characters to denote two different purposes.

Burglar Alarm, R. G. Vassar, 474,980. Filed April 11, 1887.
A burglar alarm operated by the sliding of a bolt.

Electric Signal for Engines, J. C. Rickertson, 475,066. Filed Aug. 31, 1885.
A device for indicating, at any desired distant point, the direction in which a shaft is rotating.

Conductor, Conduits and Insulators :—

Non-Conducting Material, H. W. Jones, 474,834. Filed Jan. 29, 1892.
Consists of a mixture of hair, asbestos and sponge.

Dynamos and Motors :—

Electric Motor Mechanism, E. B. Phillips, 474,857. Filed Dec. 24, 1890.
An axially-placed motor employing a system of internal gears which may be used or thrown out at will.

Armature and Dynamo Electric Machines, S. H. Short, 475,159. Filed Nov. 6, 1890.
Employs a laminated core in combination with end-pieces each consisting of an annulus, and a hub joined by radial arms and having spacing blocks interposed between the end-pieces and the core.

Armature for Electric Motors, E. C. Morgan, 474,818. Filed Dec. 12, 1891.
Comprises a pair of end plates, a cylindrical sleeve clamped between them, and soft-iron cores having coils wrapped about them, the whole enclosed by the end plates and sleeves.

Galvanic and Thermo-Electric Batteries :—

Medical Battery, P. Hathaway, 474,828. Filed April 2, 1891.

Electric Battery. A. S. Keating, 474,912. Filed Sept. 29, 1891.
Consists in placing an annular receptacle around the inside of the battery cell, in which a quantity of oil is placed to prevent the creeping of the salts.

Heating:—

Electrically Heated Matrix-Press, W. Mitchell, 474.964. Filed Dec. 4, 1891.

Electrically Heated Curling Iron, A. H. Watson & F. E. Antonini 475,169. Filed Dec. 1, 1891.

Apparatus for Cooking by Electricity, G. D. Burton & E. E. Angell 475,187. Filed May 28, 1891.
A cooking apparatus in which the heat may be regulated by simply regulating the current.

Electric Cooking Apparatus, G. D. Burton & E. E. Angell, 475,190. Filed May 29, 1891.
A simple electrical device for broiling, roasting, etc.

Lamps and Appurtenances :—

Incandescent Lamp Socket, H. S. Gutman, 474,826. Filed June 29, 1891.
Provides means whereby ready access may be had to the interior of the socket.

Electric Lamp Holder, J. B. Moore, 475,286. Filed Jan. 19, 1891.
An adjustable lamp holder for desks, etc.

Metal-Working :—

Distributing Apparatus for Heating Currents, G. D. Burton, 475,179. Filed May 14, 1891.
Has for its object to distribute heating current of different volumes for forging, etc.

Electrical Forge, G. D. Burton, 475,178. Filed May 6, 1891.
Employs means by which the supporting electrodes may be adjusted readily to receive bars of different lengths.

Electrical Metal Heater, G. D. Burton, 475,181. Filed May 26, 1891.
Method of making twisted metal bars by means of an electric heater.

Method of Electrical Metal-Working, G. D. Burton, 475,182. Filed June 29, 1891.
Relates to the electrical construction of steel and iron tools.

Method of Electrical Metal-Working, G. D. Burton, 475,183. Filed July 1, 1891.
A method of heating particular parts of the bars to be treated without affecting the intermediate parts.

Electrical Converter, G. D. Burton, 475,184. Filed Oct. 21, 1891.
Employs two continuous rings of different polarity on the outside of the converter and connected with the opposite terminals of the secondary coils.

Electric Metal Heater, G. D. Burton & E. E. Angell, 475,185. Filed Feb. 14, 1891.
Employs two series of electrodes in circuit, in combination with a mechanism for automatically reciprocating the metal to be heated between such electrodes.

Metal Heating Apparatus, G. D. Burton & E. E. Angell, 475,188. Filed May 28, 1891.
A forge for quickly heating short pieces of metal.

Electric Heater, G. D. Burton, & E. E. Angell, 475,189. Filed May 29, 1891.
An electric heater for melting metals, etc.

Flexible Electrode, G. D. Burton & E. E. Angell, 475,191. Filed June 26, 1891.
A electrode which will readily yield to the irregularities of the article to be heated in order to enlarge or diminish the contact surface at will.

Electric Metal-Heater, G. D. Burton & E. E. Angell, 475,192. Filed Aug. 3, 1891.
Provides means for the convenient performance of a number of different heating operations from the same converter.

Electric Wire-Twister, G. D. Burton & E. E. Angell, 475,193. Filed Aug. 25, 1891.
A device for heating and twisting wires electrically.

Electric Metal Bending Apparatus, G. D. Burton & E. E. Angell, 475,194. Filed Aug. 24, 1891.

Electric Forge, G. D. Burton & E. E. Angell, 475,186. Filed May 25, 1891.
A forge readily adjustable to receive and easily manipulate bars of different sizes and lengths.

Electrical Forge, G. D. Burton & E. E. Angell 475,195. Filed Aug. 25, 1891.
Provides means for conveniently and economically heating the ends of metal bars.

Automatic Electrical Forge, G. D. Burton & E. E. Angell, 475,196. Filed Sept. 16, 1891.
Adapted to grasp and release automatically the bars to be heated.

Converting System for Electric Metal-Heating, G. D. Burton & A. H. Eddy & G. T. Briggs, 475, 232. Filed Sept. 15, 1891.
Similar to No. 475,184.

Electric Metal Heater, G. D. Burton, 475,264. Filed Aug. 3. 1891.
Provides means for the utilization within a compact space of the induced current from a converter by a number workmen at the same time.

Electric Connectors for Converters, G. D. Burton, 475,180. Filed May 14, 1891.
Secures adjustability of the connectors on the converter whereby the conductors may be readily shifted. Adapted to metal-working.

Miscellaneous :—

Insulated Gear-Wheel, G. F, Lockwood, 474,913. Filed Dec. 10, 1891.

Phonograph, L. S. Clarke, 474,946. Filed Dec. 23. 1889.

Automatic Potential Regulator for Electric Currents, A. L. Ellis, 474,953. Filed Mar. 9, 1891.
Employs a voltmeter in the main circuit, opposed contacts on opposite sides of the needle, circuits connected with each of these contacts each including a motor, and an exciter dynamo, the motors being adapted the one to increase and the other to diminish the strength of field of the exciter dynamo and a resistance being placed in series with the field magnets of the exciter.

Rheostat, A. B. Herrick, 474.957. Filed Oct. 12, 1891.
Employs a resistance conductor wound on each of two insulating frames and a switch the opposite ends of which are movable over such conductors, the latter being uninsulated in the path of the switch.

Terminal and Safety Catch Connection, J. Hutchinson, 474,960. Filed Oct. 12, 1891.
The combination with main and branch terminals of an insulating screen, the positive and the negative terminals being on opposite sides of the screen in order to prevent accidental short-circuiting.

Cupping Glass with Electrical Attachment, F. Thomas. 474,977. Filed Sept. 9, 1891.

Electric Lock, F. Mergenthaler, 475,137. Filed Sept. 10, 1891.
An electric lock for the purpose of holding a door open or closed at will and operated from push buttons located at different points.

Rheostat, W. A. Sterling, 475,255. Filed Nov. 6, 1891.
A rheostat for the purpose of controlling the brilliancy of incandescent lamps.

Railways and Appliances :—

Standard for Electric Wires, E. C. Morgan, 474,847. Filed Oct. 19, 1891.
A trolley wire pole for use in mines, etc.

Electric Locomotive, C. Brown & G. H. Melms, 474,984. Filed Mar. 7, 1890.
Employs a worm-gear driving mechanism.

Electric Railway, J. W. Grantland, 475,107. Filed Jan. 14, 1892.
Employs an overhanging slotted conduit with a hollow conductor through which a blast of warm air or other drying medium constantly passes.

Electric Railway Motor, S. H. Short, 475,160. Filed Dec. 4, 1890.
An axially placed motor for street railways the armature and field magnets of which are both rotatable.

Switches and Cut-Outs :—

Electric Switch, G. Pfannkuche, 474,921. Filed Mar. 1, 1890.
A quick break non-arcing switch for currents of high potential.

Telephones and Apparatus :—

Trunk-Line System, J. J. O'Connell, 474,851. Filed Oct. 4, 1888.
Has for its object to provide ready means of communication directly over the trunk lines between operators at different boards.

ELECTRIC RAILWAY WORK AT PEORIA, ILL.

WORK on the Fort Clark Road is progressing rapidly. Nine cars have arrived. They are from the St. Louis Car Company, and are equipped with McGuire trucks. They are 16 feet long and with open platforms. The boiler-room and engine and dynamo-rooms are completed, and masons are now working on the car house.

The Central Railroad Company are going to tunnel under Central Park and the Rock Island Road to reach Springdale Cemetery which is now only reached by the Fort Clark Road. They have purchased the right of way and the preliminary survey has been completed.

ELECTRIC LIGHTING IN NEW YORK.

IT appears that considerable changes have taken place in the make-up of the United Electric Company, of this city, and that the old Brush Electric Illuminating Company has resumed business on its own account, apparently as a distinct concern. At the annual meeting of the Brush Illuminating Company held this month, Mr. W. L. Pomeroy was elected president, with Mr. G. McFall, secretary and treasurer. Mr. C. W. Spear is general manager, with Mr. A. E. Scoullar as superintendent, and E. W. Stevenson as electrician. It is stated that the Brush Company has ripped out its machines from the United States station in Twenty-ninth street, and taken them back to the Elizabeth street station, where they will now be run.

THE PURITY OIL FILTERS.

THE Purity Oil Filter Manufacturing Company, of 90 Water street, Pitsburgh, report sales of their filters to the Stanley Rule and Level Company, New Britain, Conn., and Carnegie Bros. & Co., Braddock, Pa. They are supplying a long-felt want in large manufacturing plants where the oil got very dirty, so much so that it was not practical to use the ordinary oil filter.

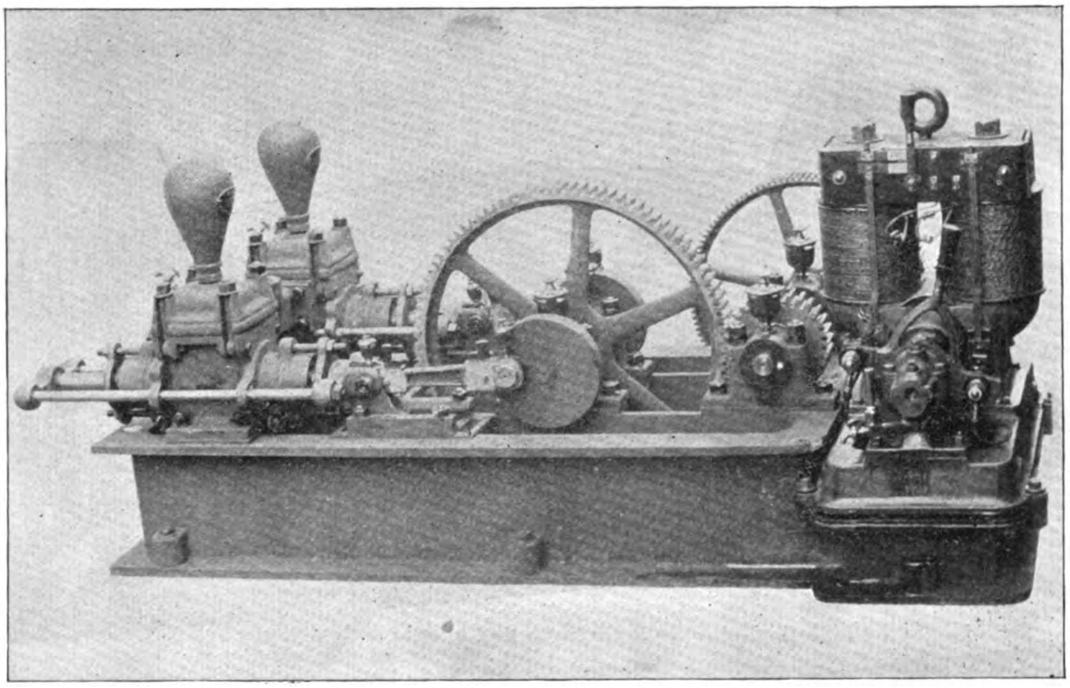
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Printer's ink is the lubricant of business machinery.

A COMBINED EDISON MOTOR AND DEANE DUPLEX PUMP.

A GOOD combination of a pump operated by an electric motor, is the equipment which the Edison General Electric Company are about to put on the market. This consists of an Edison Standard motor of the type of 1885, with a Deane duplex double-acting pressure pump upon one and the same special bedplate. These pumps have outside-packed plungers, with the valves arranged above the cylinder in such a manner that they can be uncovered for examination or repair without removal of any pipes. The covers of the valve chests are held down by swing bolts. To remove these covers it is only necessary to loosen the nuts and swing the bolts away without removing them. The pump is operated by the motor by means of a double gear. The details and arrangement are shown in the accompanying engraving, and are so clear as to require no further description.



COMBINED EDISON MOTOR AND DEANE DUPLEX PUMP.

TEST OF THE PATTON MOTOR.

A PRACTICAL test of special interest to street railway men took place at Pullman, Ill., on May 10. The occasion was the trial trip of the improved Patton engine-motor, built on order for service at Portland, Ore. While the details of this motor have already been made public, a general review of its essential features will be read with interest by all those who look for improvement in street car propulsion.

This is the first attempt to combine an electric generating plant with a driving motor, placed on a moving vehicle for traction purposes. The combination embraces a gasoline engine which drives continuously a dynamo for generating electricity, and a set of accumulators to insure a constant supply of electricity sufficient to meet the various requirements of street car traffic.

The gasoline for the engine is stored in tanks at the top of the car. The engine being entirely automatic, and being connected to the dynamo by a friction pulley, it operates as long as there is gasoline in the tank. When descending a grade, carrying a light load or standing still, the surplus current of electricity is thrown into the accumulators, to be used only when an excess of the normal power is needed. Thus the storage cells are always ready to receive that part of the current which would otherwise be lost, and to return it to the motor at such times as it is required. One of the principal features of the apparatus is that it is entirely automatic.

The inventor has arranged his cells so that they are never fully discharged, thereby removing what has hitherto been one of the greatest drawbacks to the storage battery for this work.

A unique feature of the motor is that in preparing for the daily run, the accumulators can send their energy into the dynamo, which then becomes a motor, thereby starting the engine and running it until the gas power reaches proper control; then the current is reversed, and the normal operation of the engine and dynamo commences. The labor thus required to run the car is limited to the ordinary motorman who handles the controlling switch and brake at either end of the car.

The motor may be constructed as an independent car to draw trailers, or it may be designed as a combination car, carrying passengers at either end.

All the foregoing valuable features of the motor were fully calculated out by the inventor, and have been more than realized in actual operation. The car has been running on the tracks at Pullman several weeks, and was subjected to the severest tests in climbing grades of 10 per cent., and in rounding curves at its normal speed of twelve miles an hour. We are indebted for the above details to Mr. M. J. Sullivan, the editor of the *Street Railway Gazette*, of Chicago. The motor used on the car proper is of 20 h. p., and the entire engine weighs about 14,000 pounds.

W. R. FLEMING & Co., Mail and Express Building, corner Fulton street and Broadway, this city, are installing two "Ideal" self-oiling high-speed engines in the new Naval Observatory at Georgetown Heights, Washington, D. C. As is well known, there is no more exacting customer than the Government, and these engines were selected by Lieut. A. V. Zane, of the Naval Department at Washington. After bids were received, he visited this city to investigate the merits of the different engines, and personally visited the engine-rooms to see them run. He also visited other cities for the same purpose, and on his return to Washington, the "Ideal" engines were ordered. His reason for ordering these engines was, as he expressed it, their perfectly noiseless running, as the offices in the Observatory, in order to use their instruments with accuracy, can have no noise or vibration of any kind (which would affect their proper use) in the building, and on investigation, Mr. Zane thought these engines exactly suited to his purpose.

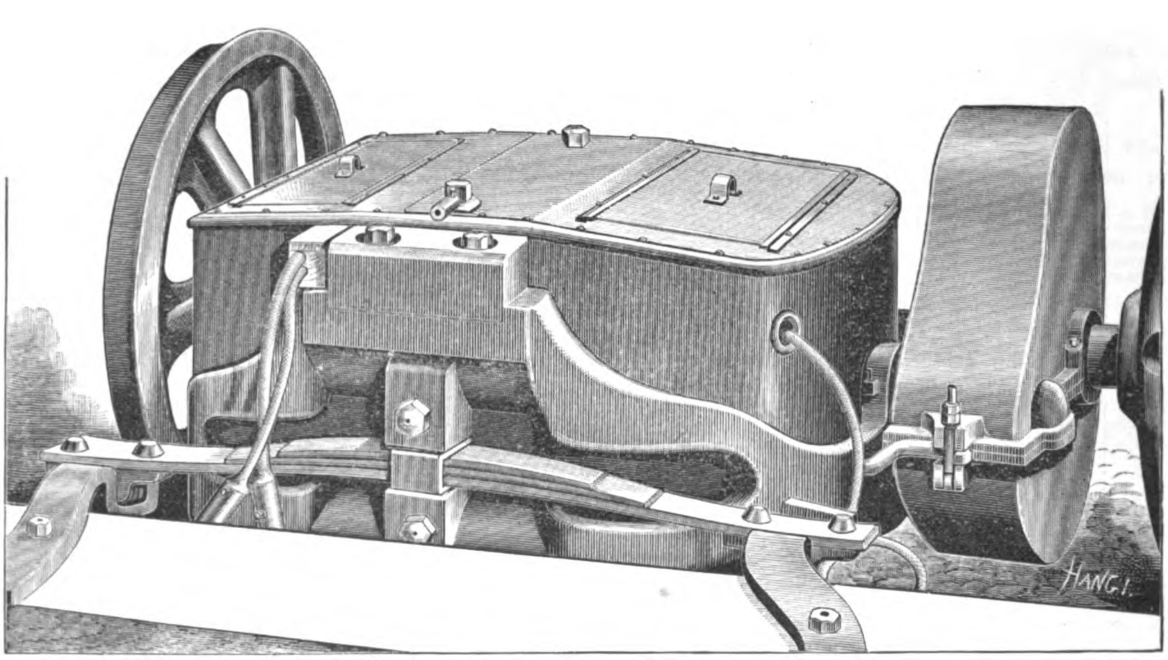
COMMONWEALTH IRON CO., Commonwealth, Wis., have recently purchased a 35 h. p. Ball engine from the Ball Engine Co., Erie, Pa.

IMPROVED WIGHTMAN 25 H. P. RAILWAY MOTOR.

The Wightman Electric Manufacturing Co., of Scranton, Pa., has again made several improvements in its street railway motor, the latest type of which is illustrated in the accompanying engraving. These improvements relate chiefly to the protection of the field windings and working parts of the motor against damage from external agencies. It will be seen from the illustration that the motor is entirely encased in a metal armor. This casing is made of sheet steel firmly riveted to the motor frame and in such a manner as to make the motor practically dust and water-proof; the arrangement of the armor also permits of ample ventilation. The under side of the motor, which does not show in the illustration, is protected in the same manner as the upper portion. This sheet steel casing does not add materially to the weight of the motor, but at the same time it offers just as much protection as the heavy castings employed in many instances.

The gear case used with the Wightman motor has also been greatly improved. It is now made of malleable iron and is in three parts, very easy to attach or take off. The arrangement of this gear case is such that no bearing parts are necessary, thus eliminating all wear on the case. It is absolutely dust-proof, and the parts are so fastened together that they will not work loose.

The controlling switch used is of the standard Wightman type, having speed controlling handle and reversing handle combined in one, making the operation of the simplest possible character. Speed regulation with this controller is obtained without the use of any external resistance above a car speed of three or four miles an hour. There are five speed contacts possible for either direction of operation.



Improved Wightman 25 H. P. Railway Motor.

Some tests recently made by Mr. J. T. Gardiner, consulting electrical and mechanical engineer at St. Joseph, Mo., where the Wightman system entered into competition with other well-known systems, gave flattering results for the Wightman apparatus. The Wightman system is now in successful operation on a great number of roads among them the following: The People's Street Railway, Scranton, Pa.; The People's Street Railway, St. Joseph, Mo.; Pennsylvania Motor Company's road at Easton, Pa.; Auburn City Railway, Auburn, N. Y.; City Passenger Railway, Altoona, Pa.; Wheeling Railway, Wheeling, W. Va.; DuBois Traction Passenger Railway, DuBois, Pa.; Brooklyn Street Railroad, Cleveland, Ohio; East Cleveland Railroad, Cleveland, Ohio.

EDISON MOTOR IN A NEWSPAPER OFFICE.

The proprietors of the *Daily Palladium*, New Haven, Conn., have, among other improvements made in their plant, discarded their steam engine, and adopted electricity as the motive power for their presses. The Edison General Electric Company have installed one of their 12 h. p. motors in the Palladium Building and the paper observes: "The motor occupies very small space, is noiseless, easy to manage, and does its work quite as effectively as the cumbersome and more expensive steam engine, and at far less expense."

SAFETY INSULATED WIRE COMPANY.

One of the best evidences of the rapidly growing popularity of the productions of the Safety Insulated Wire Company is demonstrated by their recently acquiring a most desirable addition to the quarters which they already occupy. Mr. L. F. Requa, treasurer and manager of the company is authority for the information that his company have secured the large six-story building in the rear of their present factory. The new building has a frontage of 100 feet on Twenty-eighth street and is 150 feet deep. The securing of these premises is most fortunate as it is directly in the rear of their present factory and with very slight changes can be desirably connected with all the existing departments. When completed the combined buildings will represent considerably more than double the space at present occupied by this company. The Safety are rapidly pushing to the front as one of the largest and most popular manufacturers of insulated wires.

ELECTRICAL GROWTH AT SEATTLE, WASH.

D. T. **Denny**, president of the Rainier Power & Railway Company, has made a contract which covers the construction and equipment of the new Third street railway and an extensive electric lighting system. The power station is at the Western Mills, on Lake Union. The "Short" system of railway motors has been selected and the St. Louis Car Company will build the cars, of which there will be six of the handsome vestibule type. The present lighting plant will be increased by 2,000 incandescents and 100 arcs. The National alternating, or long distance, system will supply the former and the Western Electric arc system has been adopted for the latter. This will be the first appearance of these electric systems in this State, except at Spokane, where the "Short" is used.

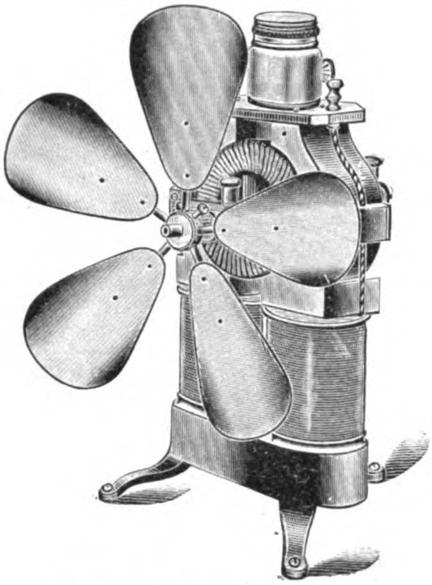
A 300 h. p. "Ideal" steam plant will also be put in at the power station, as well as two 80 h. p. National railway generators. This contract, including five miles of street construction, was awarded to the local contracting firm of Charles H. Baker & Co., who have placed their order for the steam plant with Power & Collins, also of this city.

About $100,000 will be expended under this initial contract. It is expected that cars will be running on Third street about August 1, and construction will begin without delay.

Detroit, Mich.—Frank B. Rae has brought suits against the Detroit Electrical Works for $20,000 and $25,000, respectively. His ground for one of these suits is that the defendant corporation has paid him no royalties since he severed his connection with it last fall. He asserts in the other, that the affairs of the Works were manipulated so that he was frozen out of some bonds issued by the corporation. For instance, he says that the electrical company bought up the stock of the National Traction Company which proved a loss and that this loss was assessed to the bondholders like himself.

THE LITTLE DIAMOND FAN MOTOR.

The Little Diamond fan motor shown in the accompanying engraving is manufactured by Clark & Marshall, No. 413 "The Rookery," Chicago. They have spared no expense or pains to make it perfect, complete and attractive. Among its many good features may be mentioned the ring armature which is valuable for ventilation, and in thus keeping the armature cool its electrical resistance is reduced and danger of burning is avoided. It stands 14 inches in height and has a 12-inch bright brass fan. The bearings are wide and are self-oiling.



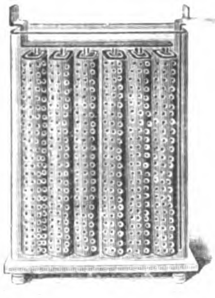
Little Diamond Fan Motor.

The Little Diamond may be regulated for two speeds, namely, 800 and 2,000 revolutions per minute. There is no sparking on the commutator, the brushes being regulated by a spring brush-holder which keeps the brushes in their proper position. This motor is designed for a direct incandescent current and may be put in operation by merely attaching it to a socket by plug and cord. It runs noiselessly and is neat in appearance.

Messrs. Clark & Marshall have increased their facilities for the manufacture of their "Little Diamond" and will be able to supply the great demand for them during the season.

THE FORD-WASHBURN STORAGE BATTERY.

The accompanying illustration shows the latest form of storage battery cell manufactured by the Ford-Washburn Storelectro Company, of Cleveland, Ohio, and already used in railway work. As will be seen, six sets of elements are employed, the negative completely surrounding the positive and consisting of receptacles of especially prepared lead perforated to allow the acid to percolate readily. The holes are not sufficiently large, however, to permit any active material to force its way out. The positive element consists of a porous pot containing active material surrounding a conducting medium of perforated lead so arranged as to compensate for expansion and contraction. The negative elements touch one another and are connected by a solid lead strip welded to all of them at the bottom, while the positive elements are similarly connected at the top. By this arrangement an evenly distributed discharge of extra strength is given to the battery. As the positive and negative elements are only separated by the porous partition one-eighth of an inch thick the internal resistance is inappreciable, while a short-circuit is impossible. The cases are made of hard rubber, tightly sealed, and the battery, after being placed upon the car, requires no attention except an occasional replenishing of the acid.



Ford-Washburn Storage Battery.

It is claimed that short-circuiting these cells and completely discharging them at the highest possible rate does them good instead of injuring them. This is an experiment constantly made. The following table gives the results of a test of six hours at the end of which time the battery was by no means completely discharged, and would, if left to itself, have risen to almost normal.

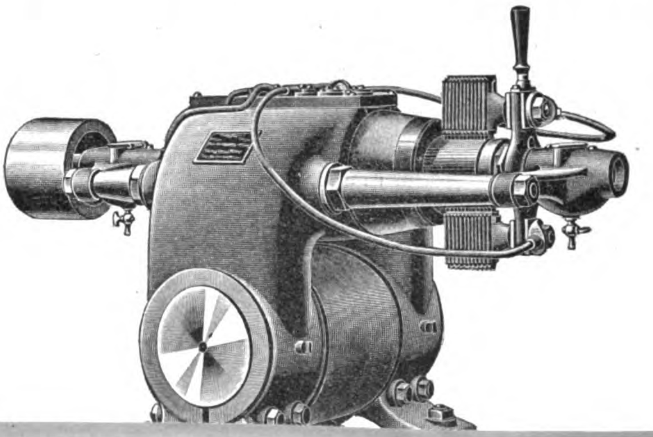
150 A. H. Cell.

V.	Am.	Time.
2.3	25	10:15
2.1	25	10:30
2.1	25	10:45
2.1	25	11:00
2.1	25	11:15
2.1	25	11:30
2.1	25	11:45
2.1	25	12:00
2.1	25	12:15
2.1	25	12:30
2.1	25	12:45
2.1	25	1:00
2.0	25	1:15
2.0	25	1:30
1.9	24	1:45
1.0	23½	2:00
1.9	23	2:15
1.8	22	2:30
1.7	21	2:45
1.6	20	3:00
1.5	18	3:15
1.4	17	3:30
1.2	16	3:45
1.2	15	4:00
1.2	14	4:15

Readings from one cell.

THE NEW JENNEY MOTOR.

The motor illustrated herewith is of the well-known Jenney type, but several new features have recently been added. All field coils are now wound upon insulated spools and afterwards slipped over the cores. The bearings are self-oiling, and in the larger sizes self-aligning. Brush holders fitted with composite carbon brushes are so attached to the rocker-arm that the carbons always press upon the commutator at diametrically opposite points. Machines above one horse power are fitted with sliding base and belt tightener. These motors are made either shunt or series in all the standard sizes and voltages. The Jenney Company, of Indianapolis, Ind , also manufacture a complete line of dynamos and power generators.



The Indiana Rubber and Insulated Wire Company, have moved their head offices from Jonesboro, Ind., to 242 Madison street, Chicago, where business will be handled hereafter. Mr. C. J. Butler is the manager of this office and with his energetic and pushing qualities will no doubt largely increase the business done by the company, who manufacture a very high grade of goods. The factory, to which have been added increased facilities, still remains at Jonesboro.

DAY'S KERITE WIRES AND CABLES.

The following circular has just been issued from Kerite headquarters, in the Mail and Express Building, 166 Fulton street:

> New York, May 18, 1892.
>
> *Gentlemen*—Having undertaken the general mangement of the long-established business of S. A. Day (successor to A. G. Day), manufacturer of the celebrated Kerite insulated wires and cables, I am prepared, after an experience of thirteen years in superintending and improving their manufacture, to supply materials of the highest standard attainable.
>
> My personal close study and contact with the practical part of this business will enable me to meet the wants of customers in every detail, and I bespeak a continuance of favors so generously accorded in the past.
>
> Very truly yours,
>
> W. R. Brixey,
> General Manager.

NEW YORK NOTES.

The Ball Engine Co., of Erie, Pa., represented in New York by Mr. F. R. Chinnock, report the following sales and shipments of recent date: Maryland Steel Co., Sparrows Point, Md., one 50 h. p. simple engine; Wilmington Street Railway Co., Wilmington, N. C., two 130 h. p. simple engines and complete steam plant; J. C. Hubinger Co., Keokuk, Iowa., one 300 h. p. cross-compound engine and condenser; J. W. Parker & Co., Philadelphia, Pa., one 50 h. p. simple engine; Chesapeake Light & Power Co., Hampton, Va., two 150 h. p. tandem compound engines and transmitting machinery; Moundsville Electrical Co., Moundsville, W. Va., one 130 h. p. simple engine; Niagara Falls Street Railway Co., Niagara Falls, N. Y., two 130 h. p. simple engines and steam plant complete; Electric Light Co., Elizabeth, N. C., one 100 h. p. simple engine; Philadelphia House of Refuge, Philadelphia, Pa., two 50 h. p. simple engines, one 100 h. p. simple engine; Edison General Electric Co., State House, Trenton, N. J., one 35 h. p. simple engine; Schuylkill Electric Railway Co., Pottsville, Pa., one 250 h. p. simple engine; Electric Light Co., Doylestown, Pa., one 130 h. p. simple engine; Somerville Hotel, St. Clair, Mich., one 35 h. p. simple engine and steam plant; Freeport Gas & Electric Light Co., Freeport, Ill., one 130 h. p. simple engine; Warrenton Electric Light Co., Warrenton, Mo., one 50 h. p. simple engine; Pittsburgh Iron & Steel Engr. Co., New Castle, Pa., one 50 h. p. simple engine, one 80 h. p. simple engine.

The Sprague Elevator has received its baptism of fire. About 6 o'clock A. M. on Thursday last a fire broke out on the third floor of the Cassidy Building, which burned through to the fourth floor, where the elevator is, and made general havoc before it was subdued. On the first inspection the elevator looked as if it were badly disabled. Insulation had melted from wires, switches had burned off, fuses gone, the controlling cylinder was split, the regulating gear was stiff and somewhat distorted, and the whole machine blackened and clogged with mortar. Part of the machinery had been flooded. It was 12 o'clock before anything could be done towards removing debris, but at 7 o'clock at night the elevator was in operation. It seemed altogether a remarkable test of reliability of electrical apparatus when well constructed. Photographs of the place were taken and are curiosities as pictures of apparent utter wreck.

The Ball & Wood Company, of 15 Cortlandt street, New York, has just shipped the eighth 150 h. p. engine within as many months to the Edison Electric Illuminating Company, of Paterson, N. J. In addition to this average of one engine per month, they have also furnished to the same company one of their improved 300 h. p. compounds. Visitors to the Ball & Wood shops at Elizabeth will now see over thirty engines under construction embracing types of their improved simple, tandem compound and cross-compound engines all on contract and in preparation for early delivery.

WESTERN NOTES.

Mr. William H. McKinlock, president of the Central Electric Company, has returned from a successful extended Western trip, having called upon many of his old friends, and customers of his company, and making many new ones. Mr. McKinlock secured an order for the entire underground electrical system of one of the larger Western cities, where Okonite wire to be used, besides other valuable trade.

Mr. M. J. Sullivan has purchased the *Street Railway Gazette* which will hereafter be conducted under his management. His brother, Mr. M. C. Sullivan, formerly connected with The Electrical Engineer, will represent him in the East. Mr. E. F. Seixas, for many years in the Edison service, will be his business manager, and Bishop & Fiske, 11 India street, Boston, will be his New England representatives. The New York office will be at 136 Electrical Exchange, and the Chicago headquarters will be in the Phenix Building. Young Mr. Sullivan has won a great many friends by his energy and ability, and bids fair to make a great success of his paper as a weekly in this field. It is understood that the first issue under his individual control will come out this week.

The Electric Appliance Company have found a new use for flexible conduit, and in addition to filling large orders for interior work, are selling a large amount as a substitute for hard-rubber tube. It is adapted for this purpose on account of its flexibility as it can be bent in any shape without injury. It also has another advantage over rubber, being non-combustible and unaffected by atmospheric action, oils or acids. As it comes in long lengths it can be cut and used in any lengths desired, thus avoiding the waste unavoidable with hard-rubber tube or any substitute for it which comes in short lengths.

Mr. William P. Williams, the well-known electrical engineer of Cincinnati, and Mr. James H. Harrison, secretary and treasurer of the Police Telephone & Signal Co., of Chicago, were callers at the Western office of The Electrical Engineer last week.

Messrs. Sargent & Lundy, the well-known consulting and contracting electrical engineers, have removed from their office in the Rookery to suite 1421 Monadnock Building where they have very handsome and commodious offices.

Mr. T. Ahearn, a member of the firm of Ahearn & Soper and also manager of the Ottawa Electric Railway Company, was a Chicago visitor last week and received his customary warm welcome from his many friends here.

Mr. H. E. Seemuller, general advertising representative of the Yale & Towne Manufacturing Co., Stamford, Conn., is spending a few days in Chicago and was a caller at the Western office of The Electrical Engineer.

Mr. James McKearney, well known in electrical circles in St. Louis, dropped in at the Western office of The Electrical Engineer last week. He is spending a few days in the city combining business with pleasure.

The Central Electric Company report considerable activity in the sale of Okonite wire, their orders for the current week aggregating one-half million feet, Manson and Okonite tape being in fair demand, as well.

Mr. Geo. A. Davis, secretary and manager of the Neenah and Menasha Gas and Electric Company, Neenah, Wis., spent a few days in Chicago last week.

WASHINGTON NOTES.

The Washington & Arlington Railway Co., whose road is being equipped with the Wheless underground electric system, have 2 of their 4½ miles completed. The conduits are being laid and the underground work will be in readiness in about three weeks. The engines and dynamos are in position and it is expected the first car will be put in operation by the first of June. On that part of the line now being completed the travel at time reaches 30,000 passengers per day, which will give the Wheless system the severest test. This portion of the road will have an equipment of eight cars. The company will start on the construction of a $200,000 bridge across the Potomac River this summer, and it will be adapted to the use of the underground system. It was only after the long and successful operation of one-half mile of experimental road which was constructed at a cost of over $50,000 that the Washington & Arlington Co. consented to adopt the Wheless system.

Congdon, Bliss & Daniels are installing a 300-light plant of the Edison system in the Oregon Avenue Apartment House; a complete 150-light Edison plant on the steamer "River Queen," now under construction at Baltimore, and have just completed the wiring of the Washington Light Infantry Armory for 300 lights. This enterprising firm are selling fan motors by the ton.

The Hanson Battery, Light & Power Co. will bring out something during June which will be very interesting to all yachtsmen.

☞ *Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.*

THE
Electrical Engineer.

VOL. XIII. JUNE 8, 1892. No. 214.

ELECTRICITY AT THE BELMONT AND SHERIDAN MINES, TELLURIDE, COLORADO.

BY

J. H. E. Waters.

IT HAS seemed to the writer that a short description of the electrical plants in use at the Sheridan and Belmont mines may prove of interest as an example of the solution of the problem of utilizing water-power situated at a distance from the points of operation; especially as in one of these instances, the cost of packing coal to the mines practically prohibits the use of steam. The mines named are in the vicinity of Telluride, a large mining centre, of which a very characteristic street view is here given in Fig. 2; while the contour of the country and the position of the electric plants may be fairly judged from the outline sketch presented in Fig. 1.

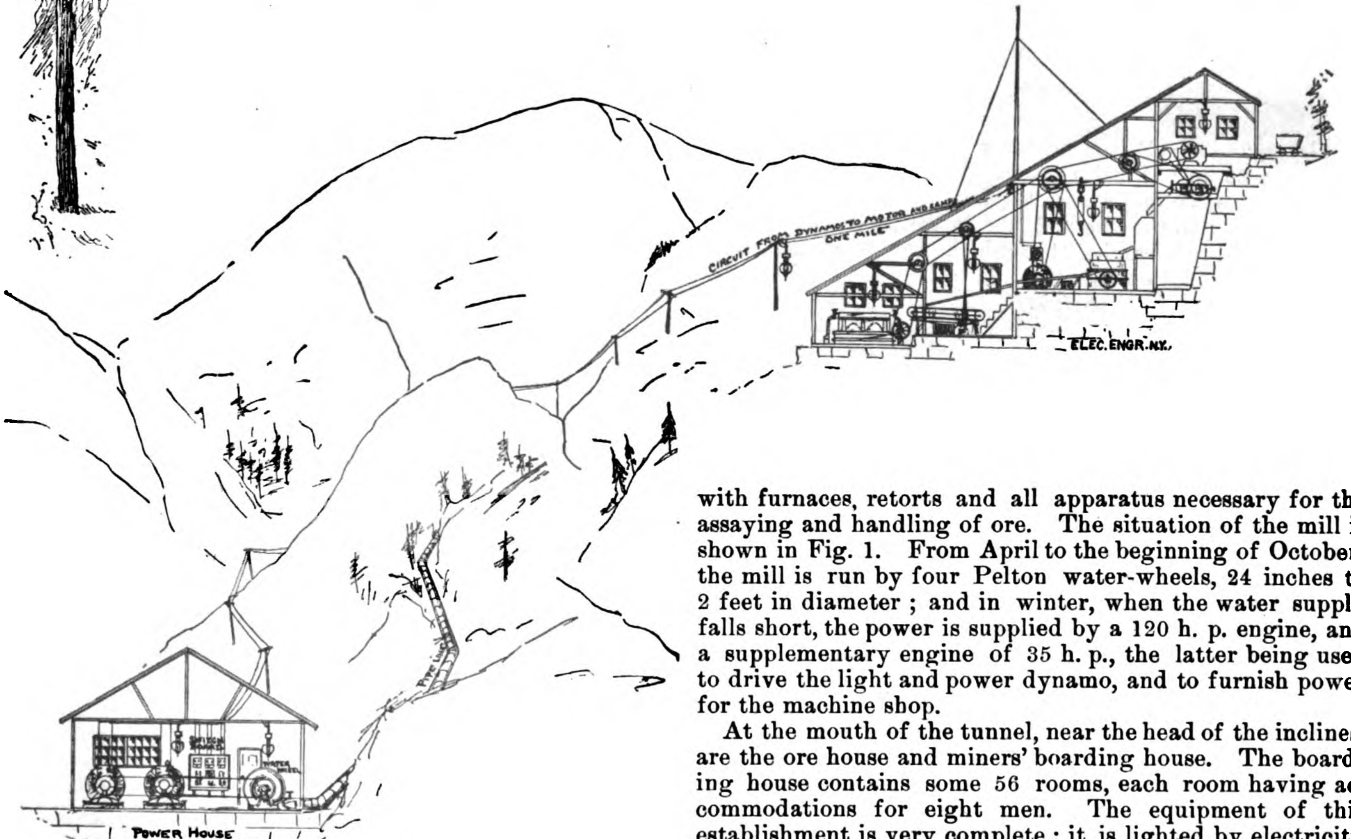


FIG. 1.—AN ELECTRIC TRANSMISSION AT TELLURIDE, COL.

The mines of the Sheridan Consolidated Mining and Milling Company are amongst the most productive in Colorado, and under the management of Mr. J. H. Ernest Waters have reached their present condition of successful and economical development. The mouth of the main crosscut tunnel is at an elevation of 2,700 feet above the terminus of the Rio Grande Southern Railroad, and at a distance of about 1¼ miles. The ore is brought down on a double track inclined cable road, 24-inch gauge, laid out and built under the direction of Mr. Waters. An endless cable is employed, and the cars are attached to the cable by a "chain clip" (patented by Mr. Thomas J. Waters, formerly of the Westport Coal Mining Company, of New Zealand), which has proved eminently satisfactory on grades up to 35 per cent., as on these inclines, and when every other device for this purpose has proved unsuccessful. The Sheridan concentrating mill is situated at the foot of these inclines, and has a capacity of 100 tons per day. It comprises crushers, stamps, Frue vanners, etc., and is provided with furnaces, retorts and all apparatus necessary for the assaying and handling of ore. The situation of the mill is shown in Fig. 1. From April to the beginning of October, the mill is run by four Pelton water-wheels, 24 inches to 2 feet in diameter; and in winter, when the water supply falls short, the power is supplied by a 120 h. p. engine, and a supplementary engine of 35 h. p., the latter being used to drive the light and power dynamo, and to furnish power for the machine shop.

At the mouth of the tunnel, near the head of the inclines, are the ore house and miners' boarding house. The boarding house contains some 56 rooms, each room having accommodations for eight men. The equipment of this establishment is very complete; it is lighted by electricity and heated by steam. The ore house is at the mouth of the tunnel, where the ore coming from the mine is sorted, the high-grade, or smelting ore being sacked and shipped directly to the smelters, while the second-class, or concentrating ore, goes to the mill.

The electrical work consists in lighting the inclines, which are snow-shedded for the greater part of their length, the ore house, boarding house, tunnel, and the main Sheridan shaft, and in furnishing power for the crushers in the ore house, and for hoisting in the mine. A "C. & C." dynamo, of 30 k. w. capacity is placed in the mill at the foot of the inclines, and while water is available, it is

FIG. 2.—A CHARACTERISTIC STREET SCENE IN TELLURIDE, COL.

driven by a 28-inch Pelton water-wheel; and during the winter, by a 35 h. p. Ideal engine. The circuit from this dynamo follows the inclines up the mountain a distance of about 8,000 feet to the ore and the boarding houses, and from this point, it is carried through the tunnel a distance of 3,300 feet, and then up the Sheridan shaft, a further distance of 1,000 feet, to the upper levels of the mine. There are 250 to 300 lights on this circuit; and in addition to these, there is a 10 h. p. motor in the ore house, which furnishes power for the crushers, and a 5 h. p. electric hoist in one of the shafts. The dynamo operating these circuits has been in constant use day and night since starting, without the least hindrance or delay of any kind, and works equally well under all conditions and changes of load. The relations of the dynamo windings to the resistance of the main circuit are in fact so nicely proportioned that the throwing on and off of the ore crushers or hoist has scarcely any perceptible effect on the lights which surround them at a distance of 8,000 feet from the dynamo.

The plant installed for the Belmont Consolidated Mining Company is of much greater capacity, and is used exclusively for operating the mill, which is located near the top of the range, in what is known as the Savage Fork of Marshall Basin. In elevation it is about 3,000 feet above the power house, and the length of the line or circuit between the two is something over 11,000 feet. The distance, however, by the trail, is about four miles. In constructing this line, great care was used to avoid places where snow slides score the mountain sides every winter. At one point, the line is carried across the path of a very heavy snow slide a distance of 800 feet, each leg of the circuit being suspended from a three quarter-inch steel cable, which is securely anchored at each end. The situation of the power house is shown in Fig. 4. The water supply is taken from the head of the stream supplying the Sheridan mill, and the location of the power house being above the level of the Sheridan flume, the tail water is carried across the gulch, as shown in the cut, and made to do duty for the concentrating mill below. In this power house are placed two 30 k. w. C. & C. dynamos, as shown in Fig. 5. This also shows the 36-inch Pelton wheel (under a head of 670 feet, and able to develop up to 210 h. p.) coupled direct to the end of the driving shaft. In the mill are placed two 30 h. p. motors, two motors being used instead of one for convenience in packing up the trail. The machinery in the mill consists of two Dodge crushers, one set of large duplex Cornish crushing rolls, three 5-foot Huntington mills, three Frue

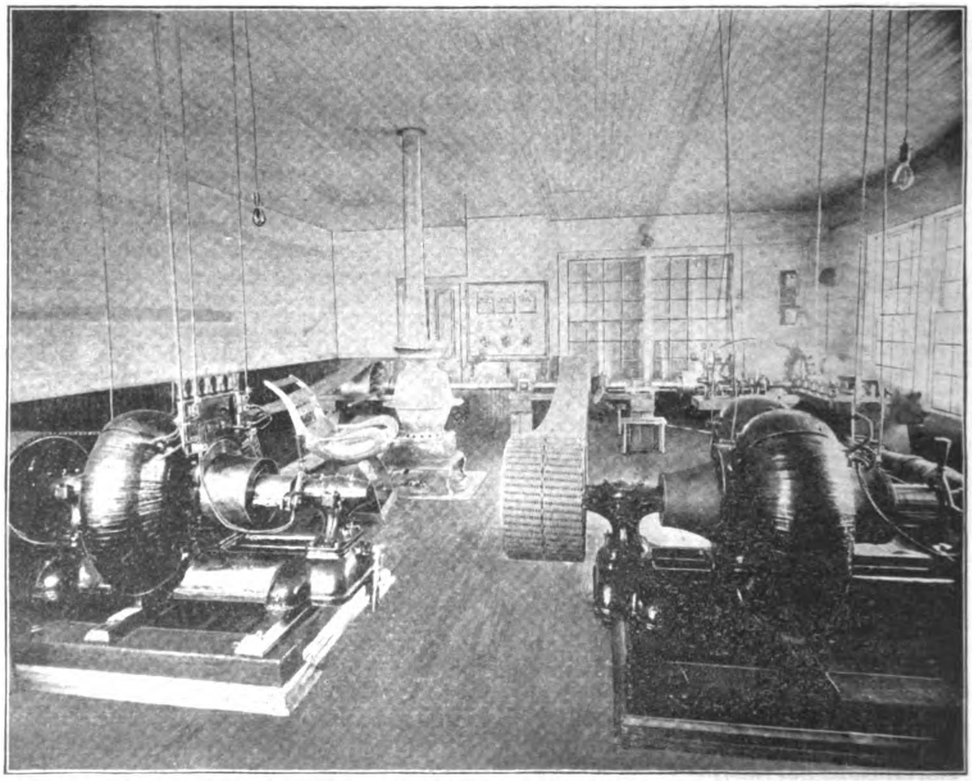


FIG. 5.—C. & C. POWER PLANT, BELMONT MINE, TELLURIDE, COL.

vanners, and six bumping tables. This machinery was furnished by Messrs. Fraser & Chalmers of Chicago.

The operation of the Belmont plant, so far, has been of the most gratifying character. During the initial run last year, and since starting up again this season, the behavior of the electric machinery has been uniformly satisfactory. The "drop" between the generators and the motors, a distance of about two miles, is only about 8 per cent.

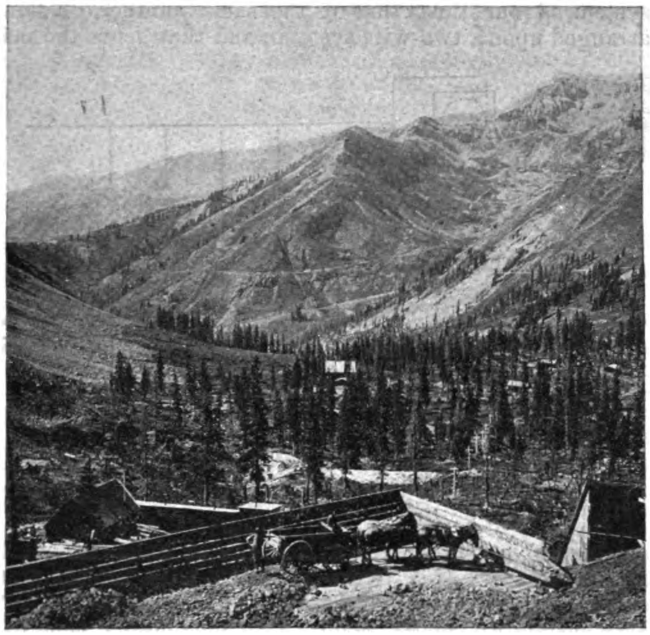


FIG. 3.—SHERIDAN MINE PLANT, SHOWING POLE LINE THROUGH TREES.

This machinery was manufactured by the C. & C. Electric Motor Company, and installed under their supervision; and it may safely be said, in view of the excellent results obtained, that it constitutes one of the most efficient and successful electrical mining plants in this State. A faint idea of some of the difficulties encountered in installing the plant may be gathered from Fig 6, which shows the slow and laborious hauling of the boilers up a steep mountain side.

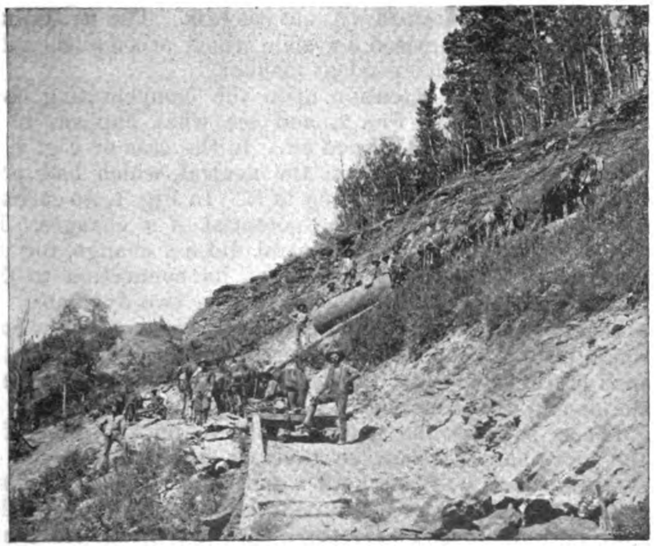


FIG. 6.—HAULING BOILERS UP THE MOUNTAIN.

A BISMUTH BATTERY.

If two bismuth electrodes are plunged into a vessel containing a solution of bismuth-chloride, or of hydrochloric acid, and if one of the electrodes is placed between the poles of an excited electromagnet, a galvanometer will show that a current flows in the liquid from the magnetic electrode. This current is always in the same direction. The electromotive force varies with the electrodes and the solutions; in certain cases it may attain .0023 Daniell when the magnetic field $= 815000\ H$, where H is the horizontal component of the earth's field. This current, says G. P. Grimaldi in *Il Nuovo Cimento*, Vol. XXV, p. 191, is due partly to the motion of the diamagnetic liquid, which is caused by the magnetic field, and it also seems to depend on the peculiar effect which magnetism appears to have on the position of bismuth in the electro-contact series.

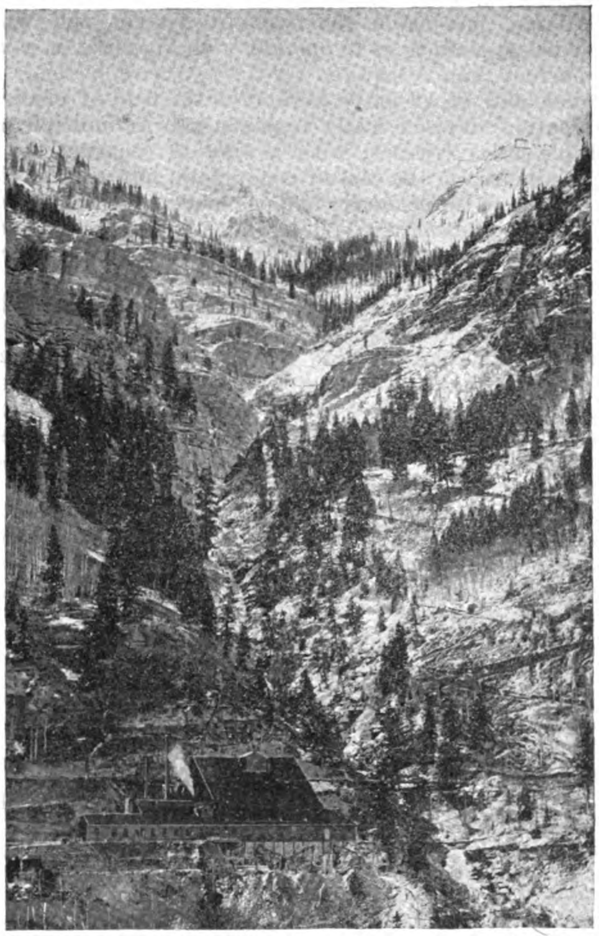


FIG. 4.—ELECTRIC POWER HOUSE FOR THE BELMONT MINE.

THE ROYAL SOCIETY.

JOHN AMBROSE FLEMING, D. Sc., who holds with distinction the chair of electrical engineering in University College, London, is one of the candidates selected by the Council of the Royal Society for election into that body. Dr. Fleming is the author of "The Alternate Current Transformer in Theory and Practice," and of many papers published in the proceedings of the Royal Society, the Institute of Electrical Engineers, and the Physical Society. Dr. Fleming gave a course of lectures at the Royal Institution on the induction coil and transformers, as well as a discourse on the experiments of Professor Elihu Thomson on the phenomena of electromagnetic repulsion.

A NEW THREE-WIRE SYSTEM.

BY

H Ward Leonard

IF there were no limit to the voltage of economical incandescent lamps we should have no especial use for the three-wire system. But, since the voltage of commercial incandescent lamps is comparatively low, the conductors required for a direct continuous current distribution on the two-wire system makes the cost of copper excessive, even at the shortest distances met with in central station practice. Therefore, there is a very great advantage in a system which enables us to operate with independent control of each lamp, just as in the two-wire system, and which nevertheless enables us to operate with higher E. M. F. and less current than is required for the two-wire system.

Brush and other early workers in the field of electrical distribution devised many ingenious series-multiple and multiple-series systems, with a view of securing the desired reduction in the cost of conductors; but none of these systems gave the necessary independence of each lamp, without auxiliary automatic devices, which were not sufficiently simple and reliable for a general commercial supply of electricity.

One of the earliest systems of this kind was devised by Edison, and is probably still in operation at Roselle, N. J. In this system one dynamo was used, having an E. M. F. three times that of the lamps, and at every point where light was required three lamps were installed in a group. The failure of any one of these three lamps extinguishes all three and they must be all of the same candle power, which does not give a sufficiently flexible system.

Fig. 1 shows a two-wire system having a dynamo whose E. M. F. is double that of the lamps which are arranged two in series, with a conductor which joins the point between each pair of lamps to each similar point between every other pair of lamps.

It will be evident that, in this system, if any one lamp, say, in group A, be extinguished, no other lamps will be extinguished thereby; but since the dynamo produces a constant E. M. F. and since now the resistance of group A is increased and is higher than the resistance of group B, the fall of potential will not be the same as before, the fall of potential on group A being greater than that on group B. That is, while the potential of the compensating conductor N was exactly midway between that of the two outside conductors P and M when the number of lamps in groups A and B were equal, the potential of N is now not midway between that of the main conductors, but is nearer that of M, so that the E. M. F. on lamps A is greater than the E. M. F. on lamps B.

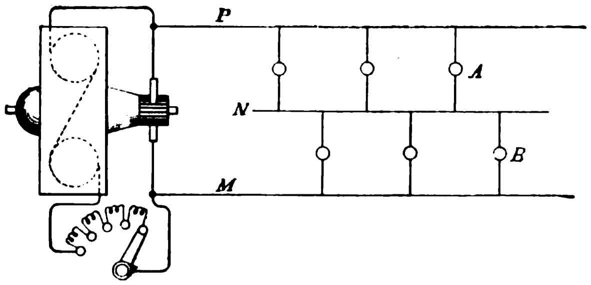


FIG. 1.

Edison devised his three-wire system to overcome this difficulty, and made use of a source of energy divided into two sources of equal and constant E. M. F. in series with each other and each having an E. M. F. equal to the E. M. F. of the lamps.

Edison's three-wire system in its usual form is shown in Fig. 2, and it is so familiar to all that I need only state that the resistance of the lamps, as grouped in a three-wire system, is four times that of the same number of lamps arranged upon a two-wire system; and that hence the main conductors of a three-wire system can be made one-quarter the size of those of a two-wire system with the same percentage of loss in the conductors. That is, while in a two-wire system we would require two conductors, each of a size and weight which we may call 1, the conductors of the three-wire system would each be of a size and weight equal to $\frac{1}{4}$. So that the two-wire system would have a total weight of $2 \times 1 = 2$; and the total weight of the conductors for the three-wire system would be $3 \times \frac{1}{4} = \frac{3}{4}$. Or in other words, we would effect a saving of $1\frac{1}{4}$ out of 2, or $62\frac{1}{2}$ per cent. This saving is based upon the use of a neutral wire, whose size is identical with that of the main conductors, which, as we shall see later, is not always necessary, so that in practice the saving is about 70 per cent; or, in other words, the cost of the three-wire system of conductors in practice is about 30 per cent. of that of the two-wire system.

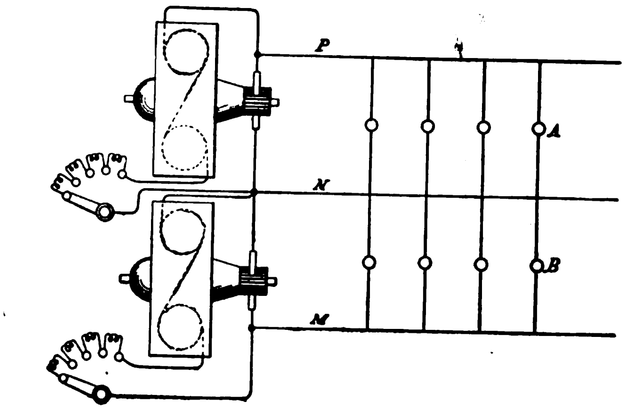


FIG. 2.

Many methods have been devised to accomplish the results obtained by Edison with his three-wire system, without the use of the divided source of electrical energy, and the compensating conductor connected to the point of division, but heretofore without success. The writer has recently however devised a system which accomplishes the same result in an independent manner.

Let us fix our attention upon the compensating conductor in Fig. 1 and Fig. 2, and see what happens to it when a single lamp is turned off. In the case of Fig. 2, a current of one lamp flows in the neutral, which had previously had no current flowing in it. In Fig. 1, *no* current flows in the neutral, but the potential of N changes. In Fig. 2, the potential of the neutral did not change, for its potential is constant by virtue of its connection to the point of constant potential between the two dynamos. It is usual considering these distributions, to consider the currents resultant upon the differences of potential, but I shall prefer to consider the potential of each wire as a more simple and direct method.

Let us suppose the potential of P to be 200, that of N 100, and that of M zero, so that we have a difference of potential or E. M. F. on both A and B of 100 volts. Also, let us suppose we have 100-volt lamps. Now evidently, since both dynamos on the three-wire system are machines of constant E. M. F. the conductors connected to their brushes will have constant potentials, which will be independent of the variations of the load on the two sides of the system, if we disregard the slight variations of potential at different points along the same conductor, which variations are no part of the present discussion.

By reference to Fig. 1, we find that the potentials of M and P will be constant and independent of the variations of load on both sides of the compensating conductor, but that the potential of N, the compensating conductor, will vary with every change in the load, so that the E. M. F. on A is sometimes higher than that on B and vice versa.

Evidently, the problem is, to keep the potential of N constant relative to the potential of M and of P, so that the difference of potential between N and the outside conductors,—that is, the E. M. F. on the lamps A and B, will be constant, as required by the lamps. One method of keeping the potential of N constant will be to connect to either of the constant potential conductors M or P a source of constant E. M. F. of 100 volts and connect the other pole of this source of constant E. M. F. to the compensating conductor N. This arrangement is shown in Fig. 3, where the source of constant E. M. F. is shown as being a battery, either primary or storage.

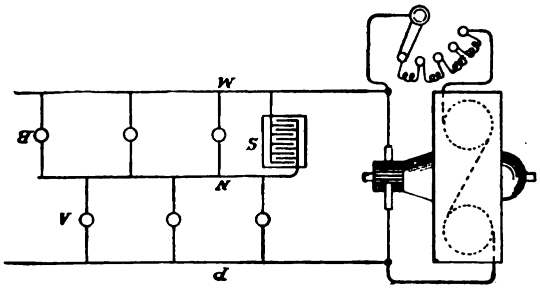


FIG. 3.

Another arrangement, Fig. 4, to accomplish the desired result will be to connect between N and one of the outside conductors M a dynamo, which is driven at a constant speed in a constant magnetic field; and hence, produces a constant E. M. F.

If the majority of the lamps are in group A the auxiliary generator C will operate as a motor, driving back upon and assisting the same engine that drives the main generator G. If the majority of the lamps are in group B, the auxiliary machine C becomes a generator and receives driving energy from the engine. If the lamps are evenly divided between A and B, the machine C will have no current through its armature, since the potential it supplies to N is exactly the same as the natural potential of N due to the fall of potential in the lamps between M and P.

Fig. 5 shows an arrangement in which a constant potential motor E drives the generator C at a point distant from the central station.

Fig. 6 shows a method of operating two towns or two sections of a town in series with each other, so as to secure the benefit due to the use of 400 volts for a distribution and yet have but one main generator, with three auxiliary generators of 100, 200 and 300 volts, respectively, supplying the necessary potentials to the three intermediate compensating conductors.

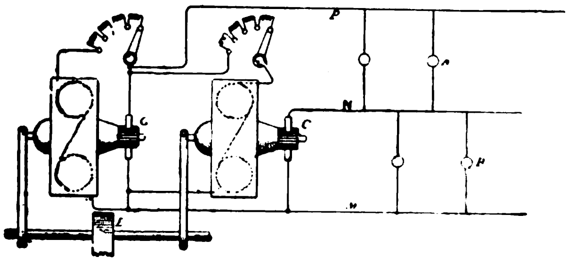


FIG. 4.

In practice in the use of this system, there is quite an advantage, due to the use of one large dynamo, for the small dynamo requires practically no attention. The field of the auxiliary generator is preferably excited separately from the main generator, so that the entire regulation of

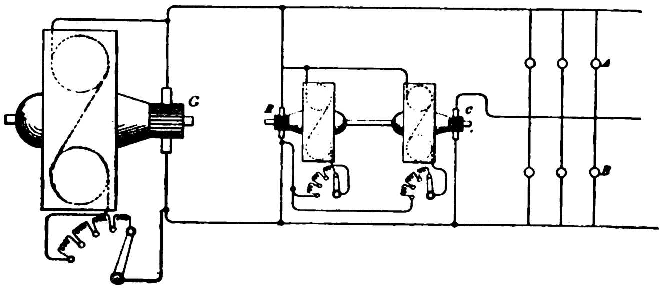


FIG. 5.

The average loss in the conductors of a three-wire system is about 40 per cent. of the loss under conditions of maximum load. If we pay consideration to the laws governing the plant is effected by the field regulator of the main generator.

As regards cost of installation, it is the general impression that under average conditions the first cost of a three-wire central station plant is greater than that of an alternating central station. This is, in reality, not the case, if the three-wire system be properly designed and the distances are those met with in usual practice. The question of first cost resolves itself into one of the cost of converters, versus the cost of three-wire feeders.

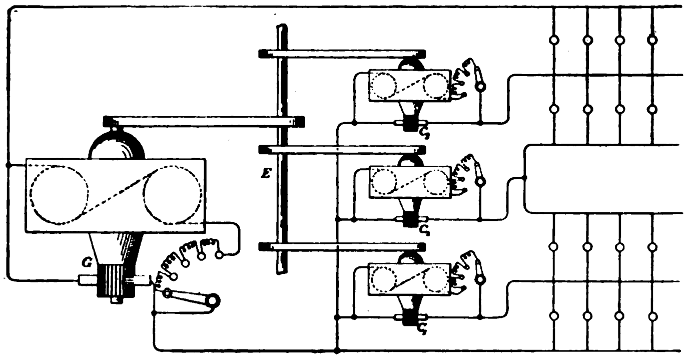


FIG. 6.

the proper loss in conductors, in order to realize a maximum economy, considering both interest on conductors and value of energy wasted therein, we shall find that, under any ordinary conditions, we should have an average loss of not less than 10 per cent.; otherwise, the interest on our investment in copper will be far in excess of the value of the energy which is wasted in them.

If our average load is 40 per cent. of the maximum, an average loss of 10 per cent. will correspond to a loss under maximum load of 25 per cent. In rare cases the average load will be 50 per cent. of the maximum, in which case the maximum loss should be 20 per cent., in order to have an average loss of 10 per cent.

The loss in the best converters, when fully loaded, is 4 per cent., and this loss is practically constant and independent of the load. Since the average load on the converters is 40 per cent. of the maximum, it is evident that the average loss in the converters, relative to the energy used in the lamps, is about 10 per cent.

In other words, the loss in a three-wire system varies directly as the load; whereas, in the alternating system, the larger portion of the total loss is constant and independent of the load. Hence, to secure the same average loss on the two systems, we must have a much larger maximum loss in the three-wire system than we do in the alternating system. But, as soon as we undertake to operate with a loss of 25 per cent. at full load, we find that a three-wire distribution presents engineering problems not at all simple, for we must not have a variation of pressure upon the lamps throughout the entire system exceeding two per cent., and to secure this uniformity of pressure, while effecting a total loss from dynamo to lamps of 25 per cent., involves the necessity of both engineering skill and experience.

The three-wire system is essentially the electrical engineer's system. The most perfect results possible are obtainable by its use, but, except when installed and maintained under guidance from an experienced electrical engineer, one of two results is certain. Either we will have a variation in pressure such as to give thorough dissatisfaction to the consumers, and an enormous expense, due to lamp breakage; or else we will have tons of unnecessary, unsightly and superfluous copper, which means sure death to any extension of the system, involving, as it does, an amount of copper increasing as the square of the distance.

Many a good central station plant, installed on the three-wire system, is to-day a monument to the plausible theory, so conspicuously fallacious in electrical engineering: "Make it large enough. It cannot be too large." Instances are common in this country where a limited territory, near the station, was wired for a maximum loss of, say, 10 per cent. The cost of copper was quite moderate, perhaps one dollar per lamp. On account of a lack of proper electrical engineering, the system soon showed a variation of five volts, with corresponding increase in the lamp breakage. Now the fatal mistake was made of putting in more copper. The maximum loss is reduced to perhaps 5 per cent., and the cost is still not excessive, being only two dollars per lamp. But a standard has been fixed, which is entirely uncommercial, and all progress in the development of the system is blocked by the useless additional copper purchased and installed on the rule-of-thumb method.

In nine-tenths of the three-wire systems in this country the area covered by the system and the capacity of the system of conductors can, by accurate electrical engineering work, be doubled, without buying an additional pound of copper beyond that already in use, and with a loss in conductors not exceeding that demanded by the considerations of best economy.

But few people realize that, with 110-volt lamps, on a three-wire system, having a maximum loss of 20 per cent. or an average loss of 8 per cent. the cost of copper is only two dollars per lamp, when the system covers a territory one mile in every direction from the station. With such a loss in distribution any commercial centre can be covered by a three-wire system, at a cost no greater than that of the alternating system, and often much less; and it presents strong advantages at present, on account of its applicability for motive power as well as light.

The alternating system, however, presents advantages on account of its simplicity, both in installation and operation, which make it far preferable to the three-wire, in cases where a system is to be installed and extended, without electrical engineering advice. To economically supply the requirements of a general electrical distribution in a town, both the three-wire and alternating systems are at present essential, and since both systems can now be supplied by a large number of different concerns, there is no reason why future central stations should not have all the advantages of both systems.

"THE BEST."

A SUBSCRIBER at West Lynn, Mass., writes us: "I consider THE ELECTRICAL ENGINEER the best magazine of electrical science yet published."

IRON PIPES FOR INTERIOR CONDUITS.

BY

Fremont Wilson

Two and a half years ago the writer was asked for an opinion in regard to interior conduits, and to the surprise of the party asking the question, he said: "Interior conduits to be successful must be able to stand the action of all kinds of alkali in plasters, and must be absolutely proof against the tools of mechanics, and, furthermore, absolutely waterproof and fireproof, and must *not* be relied upon for *insulation, the only place for insulation being upon the conductors themselves.*" The question was then asked: "Why, then, do the New England Underwriters insist upon the use of conduits, and furthermore, allow the use of such cheap grades of wire? The reply was, that any party or parties who recommended any conduit then on the market, or demanded its use, and allowed twin conductors with cotton insulation, was either ignorant of the entire subject, or was interested; for the only conduit that was needed was that used by the gas man, viz., iron pipe, to be made and installed under certain specifications. The writer also had the word of one of the largest pipe-makers that a first-class article of piping with right and left threads could be placed on the market at the same price as gaspipe, and perhaps cheaper; but the trouble with this system was, simply that it could not be patented, and therefore, underwriters, architects, and owners of buildings must be kept in blissful ignorance of the safety and feasibility of iron conduits so as to enable conduit people to line their pockets with the money of the poor public.

For this answer the writer was severely criticised by certain parties, but, nevertheless, time has proved that the remarks were correct, inasmuch, as, at the Convention held at Buffalo in February of this year, Capt. Brophy, formerly of the Boston Insurance Exchange, was forced to admit that the conduits used were a failure.

The writer over two years ago installed in New York an installation of over 3,000 lamps, and all the primary feeders connecting the various converters were placed in gaspipes. The pipes were laid on the iron ledges of the building and white core taped wire used; and, although these pipes and wires of a total length of about two miles were placed in position by inexperienced men, yet they have been in constant successful use for eighteen months, conveying a current of 15 amperes and 1,000 volts, constantly exposed to the weather; and yet we hear that it can't be done—that to install iron pipes and pull in wires for use at 50 or 100 volts pressure would be suicidal. Is not every combination gas fixture an example of conduits?

That the conduit people have seen their blunder is only too evident as we all know, from the fact of their covering their present material with metal; but let us hope that before long the underwriters will not only *allow*, but *insist* on, solid metal conduits specially built and installed in all classes of concealed work, and then, and not till then, will this everlasting hue and cry about electric light fires cease.

The New Orleans Underwriters have just adopted a stringent rule in regard to conduits, but they are simply recommending a special conduit, although it does not show on the face of their order, and they will go through the same experience, only in a less degree, that the Boston Underwriters have passed through. There is, in the writer's judgment, but one conduit; and let us learn a lesson from our enemy, the gas-man, and use it—the iron one. I may add that the Chicago Underwriters have recently stated that they are in favor of iron conduits; and the question must soon be faced by all concerned.

NOTES ON THE DETERMINATION OF WIRE FOR MULTIPLE ARC DISTRIBUTION.

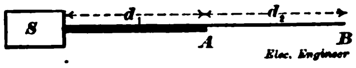
BY

H. Robinson Wellman

WHILE Mr. Woodbridge[1] has given us some instructive and interesting formulæ, they are not readily adaptable owing to the form in which he has left them. By going a little farther we can deduce from them others, equally interesting, and of far greater practical value. Taking the familiar formula

$$C.\,M. = \frac{10.3 \times C \times D}{V} \qquad (1)$$

and the case assumed by Mr. Woodbridge in Fig. 4 of his article as shown below, viz.:



Current consumed at A $= a_1$,
" " " B $= a_2$,

together with his deduction (the denominator of which I have taken the liberty of changing, thinking it must be a typographical error, and substituting $\frac{C.\,M.}{k}$ for W, we have

$$\frac{C.\,M._{\text{S. A.}}}{C.\,M_{\text{A. B.}}} = \frac{\sqrt{a_1 + a_2}}{\sqrt{a_2}} \qquad (2)$$

from (1)

$$\text{loss}_{\text{S. A.}} = \frac{10.3 \times d_1 \times (a_1 + a_2)}{C.\,M._{\text{S. A.}}} \qquad (3),$$

$$\text{and loss}_{\text{A. B.}} = \frac{10.3 \times d_2 \times a_2}{C.\,M._{\text{A. B.}}} \qquad (4)$$

(3) and (4)

$$\frac{\text{loss}_{\text{S. A.}}}{\text{loss}_{\text{A. B.}}} = \frac{\dfrac{10.3 \times d_1 \times (a_1 + a_2)}{C.\,M._{\text{S. A.}}}}{\dfrac{10.3 \times d_2 \times a_2}{C.\,M._{\text{A. B.}}}}$$

$$= \frac{d_1 \times (a_1 + a_2)}{d_2 \times a_2} \times \frac{C.\,M._{\text{A. B.}}}{C.\,M._{\text{S. A.}}}$$

Substituting from (2),

$$\frac{\text{loss}_{\text{S. A.}}}{\text{loss}_{\text{A. B.}}} = \frac{d_1 \times (a_1 + a_2)}{d_2 \times a_2} \times \frac{\sqrt{a_2}}{\sqrt{a_1 + a_2}}$$

Reducing

$$\frac{\text{loss}_{\text{S. A.}}}{\text{loss}_{\text{A. B.}}} = \frac{d_1 \times \sqrt{a_1 + a_2}}{d_2 \sqrt{a_2}} \qquad (5)$$

∴ The loss should be proportional to distance × $\sqrt{\text{current}}$.

Let $V =$ total loss $= \text{loss}_{\text{S. A.}} + \text{loss}_{\text{A. B.}}$.

Then, $\text{loss}_{\text{A. B.}} = V - \text{loss}_{\text{S. A.}}$. Substituting in (5),

$$\frac{\text{loss}_{\text{S. A.}}}{V - \text{loss}_{\text{S. A.}}} = \frac{d_1 \times \sqrt{a_1 + a_2}}{d_2 \times \sqrt{a_2}}$$

$$\therefore \text{loss}_{\text{S. A.}} = \frac{V \times d_1 \times \sqrt{a_1 + a_2}}{d_2 \times \sqrt{a_2} + d_1 \times \sqrt{a_1 + a_2}} \qquad (6)$$

$$\text{and loss}_{\text{A. B.}} = \frac{V \times d_2 \times \sqrt{a_2}}{d_2 \times \sqrt{a_2} + d_1 \times \sqrt{a_1 + a_2}} \qquad (7)$$

(6) and (7) are, I believe, the most convenient forms in which they can be left, as they tell us how to proportion our *losses*, and leaves us free to use any formula, chart or other method that we may prefer, with which to calculate our millage; though we could continue and produce formulæ giving us the area direct, without the determination of the losses. The same reasoning applied to Mr. Woodbridge's second deduction gives,

$$\frac{\text{loss}_{\text{S. A.}}}{\text{loss}_{\text{A. B.}}} = \frac{d_1}{d_2}; \text{ from which we get } \text{loss}_{\text{S. A.}} = \frac{V d_1}{d_1 + d_2}, \text{ and}$$

$$\text{loss}_{\text{A. B.}} = \frac{V d_2}{d_1 + d_2}.$$

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[1] See THE ELECTRICAL ENGINEER, April 13.

THE APPLICATION OF LOGARITHMS IN CALCULATING SIZES OF ELECTRIC CONDUCTORS.

BY

Thos. J. Fay

FEW indeed are the problems to which logarithms may not be applied to advantage. In the solution of problems involving involution and evolution they are indispensable. However, with practice, so that one can handle them quickly, the ordinary calculations involving multiplication and division may be handled quickly and accurately, and that too, with a great reduction of mental labor. In fact logarithms may well be called "the lazy man's method." Those engaged in laying out wiring plans, know well the tediousness of such an undertaking requiring, as it does, many repetitions of the same formula. No doubt the monotony of the work makes it such that errors are liable to creep in, purely from that cause.

The method of applying logarithms in this case differs in no way from that of the ordinary or Briggsian method. Any table of common logarithms may be employed. In the following table the logarithms are those of the constants for given losses in volts, and are used as shown in the formula:

Volts loss.	Log.	Volts loss.	Log.
1	1.326541	6	0.547775
2	1.025806	7	0.481443
3	0.849419	8	0.423246
4	0.724276	9	0.369216
5	0.627366	10	0.326336

log 4 = 0.602060.

FORMULA.

$\log d^2 = \log C + \log D + \log V$, for 2-wire system.
$\log d^2 = \log C + \log D + \log V - \log 4$, for 3-wire system.
$d^2 =$ area in circular mils.
$C =$ current in amperes.
$D =$ distance in feet from source of supply to delivery.

Example.—It is required to find the area in circular mils of a conductor which will carry 100 amperes of current 800 feet, with 4 volts loss.

Solution.—Log 100 = 2.000000.
" 800 = 2.903090.
" V = 0.724276.
" d^2 = 5.627366, for 2-wire system.
" 4 = 0.602060.
" d^2 = 5.025306, for 3-wire system.

This calculation is explained as follows:

The number represented by log 5.627366 is 424,000, which is the required area in circular mils for the 2-wire system. The number represented by log 5.025306, is 106,000, which is the required area in circular mils for the 3-wire system.

Heating Effect.—It will be remembered that wiring formulæ are not always applicable; that is, the area of the wire as found is insufficient in many cases to carry the current without undue heating. After computing the size of wire by formula it is always essential that it be compared with some standard for *safe-carrying capacity.*

The following method by logarithms may be found easy to work; the result has been practically tested, and is known to be correct:

$$\log C = \frac{(\log d \times 3) - 3.397940}{2}$$

d = diameter of the conductor in mils.

C = current in amperes.

Example.—It is desired to find the safe-carrying capacity of a wire 460 mils in diameter.

$$\begin{array}{rr} \textit{Solution.}\text{—Log } 460 = & 2.662758 \\ & \underline{3} \\ & 7.988274 \\ & \underline{3.397940} \\ & 2\overline{)4.590334} \\ \log C = & 2.295167 \end{array}$$

The number corresponding to log 2.295167 is found to be 197.31. Hence, 197.31 amperes is the safe-carrying capacity.

It is assumed in working these problems that the conductors are of 96 per cent. conductivity and that they will heat 30 degrees Fahrenheit over the surrounding temperature when covered with average rubber insulation taped and braided. The specific resistance is taken at 75 degrees Fahrenheit.

SOME ABNORMAL EARTH CURRENTS.

BY

D. B. Grandy

I have recently encountered phenomena in the domain of earth currents which varied somewhat from the ordinary manifestations with which I am familiar, and an account of which may be of interest.

One of the lines of the Postal Telegraph-Cable Co. carrying three wires, traverses a section on the east bank of the Mississippi, between Venice and Alton, Ill., which was inundated during the recent flood. At one point, about 10 miles from St. Louis, two poles were washed out and two of the wires were broken and fell into the river. The third wire pulled out its pins and remained intact, spanning the break in the pole line, and clear of the water. On grounding the two broken wires at the St. Louis office, a current was formed of sufficient strength to work the instruments on both wires. The current was negative in polarity, with an E. M. F. of about 13 volts, as shown on a voltmeter. The current remained steady, with no perceptible fluctuation for several days, until the wires were taken out of the water and restored to their normal condition. During that time the two broken wires were kept open at Alton, beyond the break; the only "live" wire within three miles of the break was the third wire on the same line, the opening of that at Alton did not affect the current on the other two wires in the least; so that there would seem to be no doubt about the current in them being an earth current.

We have another instance of a permanent earth current in one of our city wires. The wire extends about five miles to a point in the southwestern part of the city where it is "grounded" on the water pipes in a manufacturing establishment, several blocks away from any electric railway or line of telegraph wires. On grounding this wire at the main office, a negative current with an E. M. F. of 15 volts shows itself. This current has remained at its present strength for over five years, and fluctuates but little. The current is amply sufficient to work the wire without the use of any battery.

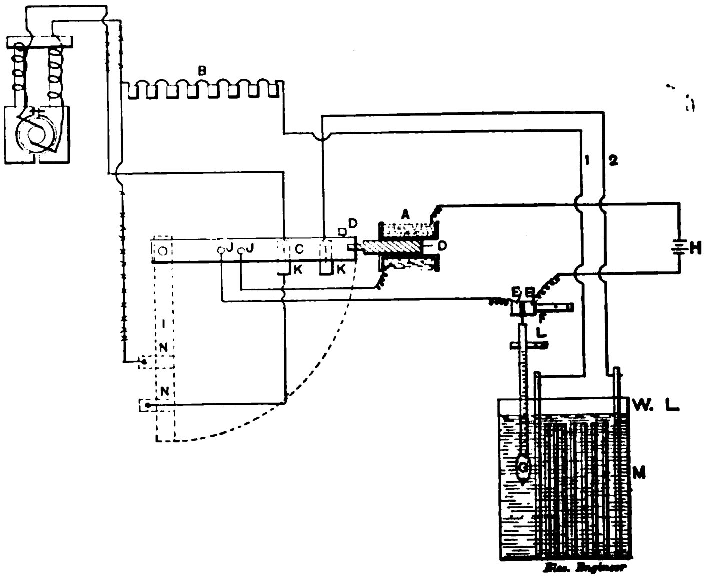
In many other wires the earth current is found to be appreciable on an ordinary relay, but does not approach the instances cited in strength or permanence.

PEARSON'S AUTOMATIC STORAGE BATTERY CUT-OUT AND SWITCH.

BY

J. J. Pearson, E. E.

In installing secondary battery plants one of the chief difficulties the engineer encounters is the trouble in instructing the attendant in the use of the hydrometer to determine the amount of the charge. An incident of this kind suggested an arrangement which the writer constructed about a year ago, and which has since proven to work very satisfactorily, being very sensitive and positive in its action. One cell of the working plant, as shown in the accompanying diagram, is extended by means of the wires 1, 2, to a suitable shelf or case so as to retain its original position in the circuit. A hydrometer G bearing a cap of aluminum, and contact pin F is suspended in a perpendicular position by means of the support L, in which it moves freely and also acts as a guide to the terminals E E, which should be made so as to be adjustable to a higher or lower position. The operation is as follows:



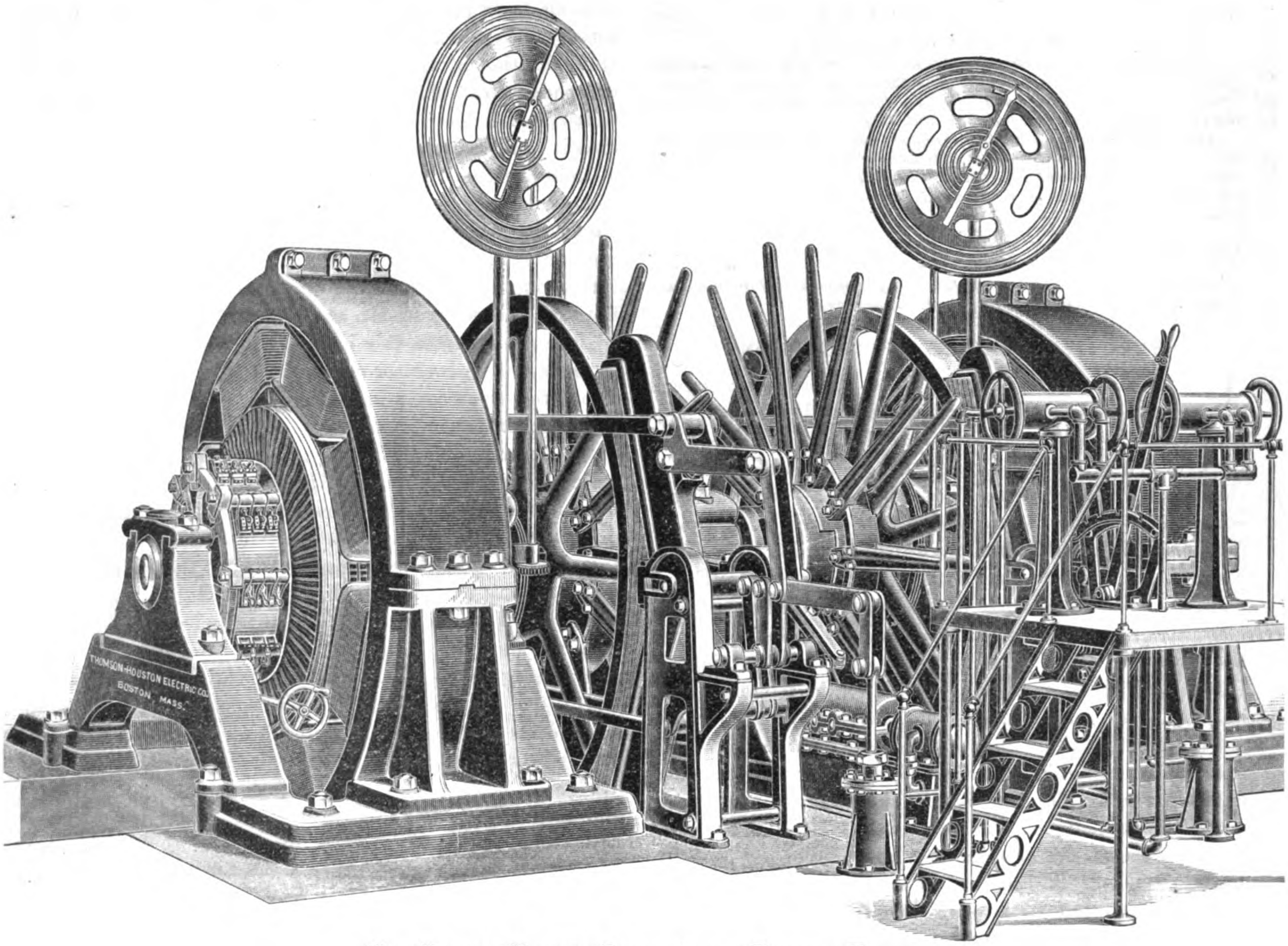
Pearson's Storage Battery Cut-Out and Switch.

The switch bar C, being thrown up in its position for charging, is locked in this position by the lug in the end of the movable core D, acting in solenoid A; this throws the charging current at K K through battery B, which continues as long as the hydrometer is below the proper density point. But when the solution reaches the proper density the hydrometer rises, closes the local circuit at E E, which pulls out the lug at the end of the movable core D, engaging the end of bar C and allowing it to drop by gravity or spring, cutting out the battery and throwing in lamps or resistance at N N. This same operation opens the local circuit J J. The instrument remains in this condition until discharged, and the bar C is again thrown into position.

The cell M should have a thin film of oil poured over the solution to prevent evaporation, and care should be taken to always have the solution at the proper height by means of water lines W L.

NEW THOMSON HOUSTON DIRECT-ACTING ELECTRIC HOISTS.

The rapid hoisting of heavy loads from deep mines by the direct application of the power to the reel shaft without the intervention of gearing, offers the most favorable conditions for the use of the electric motor in hoisting work. Much greater economy can be shown in the use of power, while a high hoisting speed can be safely and easily attained—a matter of importance where large quantities of ore are to be handled. Having in mind the fact that gearing has its limits, both in speed and safety, the Thomson-Houston Electric Co. have just brought out a new direct-acting electric hoist designed in general to operate with flat wire rope. The hoist, which is shown in the accompanying engraving is operated by two M. P. type motors, one on each end of the reel shaft, each capable of developing 500 h. p., or having a combined output of 1,000 h. p. This hoist is designed to raise a load of 10,000 pounds from a depth of 2,500 feet in one minute. Of course, for hoisting and lowering men, or for other purposes, any desired speed can be obtained at the will of the operator. Lowering can be done under complete control of the motors and without the use of the brakes when desired. Post brakes of a very powerful and effective type are used, being drawn together by rods above and below the reel shaft, so that all parts move in parallel lines, distributing the wear equally on the brake shoes and applying the pressure at two points in each shoe equally distant from the centre. The shoes are also pivoted at the centre, so as to quickly adjust themselves to the faces of the brake wheels. The clutches are of the jaw type, that portion of the shaft upon which they slide being hexagonal in form. Both clutches and brakes are operated by cylinders using compressed air, a small air compressor driven by an electric motor placed at the centre of the hoist supplying air for this purpose. The compressor requires no attention whatever, being automatic in its action; stopping when the pressure in the receiver forming its base reaches a certain point, and operating entirely independent of the hoist. Two sets of valves, actuated by hand wheels, one for the brake and one for the clutch, are placed convenient to the operator on each side of the centre of the hoist, each set controlling the brake and clutch on its side.


THOMSON-HOUSTON ELECTRIC CO.
BOSTON, MASS.

New Thomson-Houston Direct-Acting Electric Hoists.

The brake wheels, reels, etc., are, as will be seen, of the usual form, the brake wheel being keyed to the hub of the reel, which runs loose upon the shaft when not in clutch. The reel hubs are bushed with hard composition, means for their thorough lubrication and easy removal being provided.

Dial indicators operated by worm gears on the reel hubs are attached to each reel, showing the position of the cage in the shaft. All levers are arranged within easy reach of the operator, so that one man can attend to both reels and brakes without difficulty.

Only about one-half the space of steam hoists of the same capacity is occupied, insuring a great saving in buildings and foundations alone, while the well-known economy of the electric motor in the use of power makes its application to direct-acting hoists requiring large power of the utmost importance in a commercial sense. We may add that these hoists are built in sizes from 500 to 3,000 h. p.; the largest being capable of lifting a weight of 32,000 pounds from a depth of 3,000 feet at a speed of 3,000 feet per minute.

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No man can learn what he has not preparation for learning, however near to his eyes is the object.—Emerson.

SELECTIVE SIGNALS IN TELEPHONY.

EVER and anon, branches of an art which have remained in a quiescent state are suddenly called into prominence, and the most recent example of this is to be found in the field of telephony. Many of our readers will remember that shortly after the telephone became a practical and commercial success the need was recognized of a simple device which would enable more than one subscriber to be placed upon a single line without interference with one another. Yet after nearly fifteen years of trial and experiment the fact remains that "individual calls" have not been introduced. Even with all the other needs which are still the subject of work and speculation in telephony, we believe we are safe in saying that there is no more important requirement to be filled in this field than the introduction of a thoroughly reliable and commercially practical individual call. The time is not far distant when, in our large cities at least, it will become a matter of absolute necessity to place more than one subscriber on one line. To state the case in another way it is problematical whether if the number of subscribers in New York City were raised from the present number to three times that number, or say thirty thousand, the telephone business would be a paying one at the rate charged at present. The individual call would be one great factor, though not the only one, it is true, in handling a business of this magnitude effectually; and hence it would be well for electricians to devote their serious attention to the solution of this problem. Mr. Thomas D. Lockwood deserves the thanks of all workers in this field for the admirably clear and succinct manner in which he has presented a digest of the state of the art of individual signaling, in his paper read before the American Institute of Electrical Engineers, at Chicago. As he puts it, much time has been wasted by inventors in the past, owing to a lack of knowledge on their part of telephone work done in this department, in which alone no fewer than one hundred and sixty-one patents have been issued in this country. Besides that, however, he points out what ought to be avoided and what is essential to a successful instrument of this type,—information which many have long sought at great sacrifice of time and money.

LEONARD'S THREE-WIRE SYSTEM.

THE distribution of current viewed from the standpoint of economy in copper has from the first been the study of all electrical engineers, and was naturally forced more particularly on those who chose the methods of low tension distribution. Even Mr. Edison, who has always advocated putting down plenty of copper, saw the limitations which a two-wire system placed upon low tension distribution, and the evolution of the three-wire system was the natural consequence of a demand for a method which, while permitting each lamp or other "translating device" in the circuit to be manipulated independently of every other and at its original low potential, still allowed of an appreciable reduction in copper. The practice inaugurated by Mr. Edison has since been adhered to almost without a single modification, except in detail, and hence it is all the more interesting to note a departure in this method of distribution as proposed by Mr. H. Ward Leonard and described by him elsewhere in this issue. Mr. Leonard shows how by means of a generator connected to the two outside wires of a three-wire system in conjunction with a smaller auxiliary generator or motor as the case may be, the current in the neutral wire can be taken care of and the system be maintained in equilibrium. Incidentally Mr. Leonard also points out a few considerations of the highest importance in the designing of a three-wire system, and shows how in the effort to reduce the losses on a part of the system the remainder may be seriously affected. If Mr. Leonard's bold statement that nine-tenths of the three-wire plants in this country could be doubled in capacity by good electrical engineering is true, then there is a field here alone which might give our electrical engineers work for a long time to come without the need of looking for new fields to conquer. We fully agree with him, nevertheless, that the three-wire system is still open to vast extension and improvement, and need only recall to our readers the excellent work now being done in Brooklyn, N. Y., by Mr. W. S. Barstow, an account of which has already appeared in these columns.

GOVERNING STEAM ENGINES ELECTRICALLY.

As the electric art advances, engineers are constantly brought face to face with imperfections in the older types of machinery which are employed as auxiliaries, of which the steam engine is probably the most conspicuous example. Much has already been done towards the improvement of the steam engine as a prime mover, especially in the direction of its regulating properties. This was justly deemed necessary in the early days of electric lighting, where the slightest inequality in the speed showed itself perceptibly in the character of the light; but regulation has more recently become a matter involving, not merely a question of smoothness in working, but also of economy. It was early suggested that electromagnetic apparatus might be emlpoyed for the regulation of engines driving electric machines, and several devices of this nature will be recalled by our readers. They consisted almost without exception in throttling governors, and were, in consequence, but ill adapted to the finer regulation and economy desirable. In investigating the methods by which the best results in electric governing can be obtained, Mr. Wm. S. Aldrich, of the Johns Hopkins University, in a paper read before the American Society of Mechanical Engineers, at its San Francisco meeting, points out that an electromagnetic mechanism under control of the turning movement of the dynamo, or of its external electric circuit, can be used by introducing the dynamometer governing principle, while the centrifugal governing power may be introduced to control the engine when there is no load on the dynamo. By employing a "rotary-piston" valve, a compound movement may thus be obtained by giving the centrifugal valve governor control of the reciprocating, and the electromagnet mechanism control of the rotary movement. It is evident that a variety of forms of apparatus is open to the electrical engineer for carrying out this method of compound governing. With a valve so controlled the distribution of steam on a multiple expansion engine, for electric railway service, for instance, could be controlled in a manner far better than is now done with the centrifugal governor alone. It is also apparent that with such a system of governing the weight of the fly-wheel necessary to obtain the necessary uniformity of speed might be considerably reduced. We hope that Mr. Aldrich may succeed in having the ideas put forward by him carried out in a practical way, as the method suggested seems well worthy of a fair trial.

THE VALUE OF CONDUITS FOR WIRES.

An article by Mr. Fremont Wilson in our columns this week describes on installation made by him in this city of over 3,000 lights, in which the wires are carried through iron pipe. The plant has been very successful, he says, and he comes out therefore as a strong advocate of solid metal conduits. The fact recorded is very interesting, and it would seem that iron pipes have an important place in electric lighting economy, but we cannot follow Mr. Wilson in his attack on interior conduits of the type with which we are now all familiar. There are two or three such now before the public, and the manufacturers of one of them at least deserve all the benefit they can get from the indisputable fact that they were first and foremost in promoting the plan of "piping" the electric light wires. We have always looked upon that as one of the greatest advances made in incandescent lighting, and we believe the time is rapidly approaching when interior wires will be run through tubes only, and will not be permitted to ramify in any other way in any building whatsoever. As to the patent side of the question, it seems only natural that in developing tube systems, ideas and methods of great value, if covered by patent, would be developed; and if that is the case, it is to be hoped that in this field as in every other where the inventor works, the patentees will be able "to line their pockets with the money of the poor public." We are only at the beginning of incandescent lighting, and therefore everything that will add to its convenience, safety and flexibility is to be encouraged. That there should be a fight, and a vigorous one, for the control of new and valuable features of wiring is only natural, but we must confess that our sympathies are with the men who spend time, money and brain power in perfecting those features rather than with the people who want to use them for nothing. Mr. Wilson is of the opinion that he has hit upon one method free from patent royalties. If so, no one is injured.

LIGHTING THE WORLD'S FAIR.

Reference was again made in these columns, last week, to the contract secured by the Westinghouse Electric and Manufacturing Co. to furnish the incandescent lighting for the World's Fair, and to the large amount of the bond required from Mr. Westinghouse, namely, $1,000,000. It is now reported from Chicago that Mr. Westinghouse has gone to that city to obtain, if possible, a reduction in the amount of the bond, and that he is quite willing to stake $500,000. While it is most essential that the lighting should be a sure thing, we cannot but feel that the terms have been made unduly onerous, and that Mr. Westinghouse is right in his contention. If bonds of this magnitude were asked every time a plant of 5,000 or 10,000 h. p. was required, electric light and power would not make anything like the headway they are now doing. We may be wrong, but the prices of the contract are so low that for that reason alone the Westinghouse Company ought to receive generous treatment. It certainly stands to make very little out of the contract, probably nothing except "the ad. there is in it," which is very much like the benefit derivable from bill posting; and the company is therefore entitled to the consideration due a low bidder under the circumstances. The price, if we are not mistaken, now stands just short of $400,000. For that sum Mr. Westinghouse will be called upon to furnish 83,410 incandescent lamps of 16 c. p. each and 6,212 lamps of 10 c. p. each, making a total of 89,622 lamps. In addition he will furnish 8 arc lamps of 2,000 c. p. each, which will be installed in the dome of the Administration Building. Can anybody else be very anxious for the contract at that price?

SPARKING AND FLASHING IN DYNAMOS.

In a paper read before the Chicago Electrical Association on the above subject, Mr. F. R. McBerty has analyzed the actions which take place in the passage of a generating coil on the armature and showed how the ideal non-sparking conditions are modified by disturbing actions. Taking for an example a Gramme wound armature, Mr. McBerty pointed out, how the self-induction of the armature acted to cause flashing upon a change of load, and the difficulties it introduced in effecting regulation. One method of overcoming the difficulty is to employ a brush are rather a multiple brush covering a portion of the circumference of the commutator; in that case the brushes must be placed a little forward of the neutral line, in order to fulfil the conditions necessary to prevent sparking. Mr. McBerty's paper presented the subject in a very clear manner and we remark that in the new edition of "Dynamo Electric Machinery," Prof. Sylvanus P. Thompson adopts a similar method of explaining the phenomena of sparking.

SELECTIVE OR INDIVIDUAL SIGNALS.[1]

BY THOMAS D. LOCKWOOD.

THE USE OR FUNCTION OF SELECTIVE SIGNALS IN TELEPHONY.

THE business of the average user of the telephone keeps a line employed but for a very small part of the entire business day, and for the remainder of the time the line wire is idle and earning absolutely nothing. If by any means it could be made possible to place several sub-stations in connection with the same circuit, without materially affecting the efficiency of the service rendered, it is obvious that the earning power of the circuit would be largely increased. But a call-bell or other signal is clearly necessary in order that the attention of the station may be attracted when some other station desires to communicate, and as we add stations to a circuit we also necessarily add call-bells; thus introducing two practical objections, viz:

1. A most incessant and annoying ringing, because a call sent to any station is heard at all stations.
2. The necessity of distinctive signals, whereby when the bell at any station is rung the attendant may know whether the call is for his or for some other station.

At this juncture the selective signal steps in, and its special work or function may be thus stated: That two or more stations being electrically connected with the same circuit, the call-bell at any predetermined or desired one of such stations may be operated, and the call given there, to the exclusion of the call-bells at the other stations, which at the same time remain quiescent, or are silent.

This statement of function justifies the term "*selective signal*" which I have adopted, and which I conceive to be more appropriate than the old term "individual signal" because more descriptive.

HISTORICAL SKETCH OF SELECTIVE SIGNALS.

The idea of producing a practical selective signal is not (as might from the introductory remarks of this paper have been supposed) one which made its first appearance subsequent to the advent of the telephone.

Appliances possessing the same characteristics appeared in England many years ago, and several forms have from time to time been patented in this country for use in connection with telegraphy, which closely resemble some of the forms which within the last 10 or 12 years have been reinvented and patented here.

One of these[2] is based upon combinations of a plurality of line wires, two or more of which extend from a terminal to each two sub-stations.

A second[3] involves two wires together with the use of both directions, and varying strengths of current; and states itself to be "for sounding any particular alarm in a set of telegraph stations."

The third,[4] quoting from the published abstract, is for "transmitting secret intelligence to any one or more stations without the use of extra wires. At each station a metallic disc, suitably inlaid with non-conducting portions, is brought to the required position in order to complete the circuit or not, by any electromagnetic step-by-step movement, thus excluding or including the telegraph instrument at any particular station or set of stations as required."

Three other British patents prior to 1876 are of this class, [5, 6, 7] one of which[5] speaks of "an apparatus comprising a main line, a series of independent branch or station lines at each end, and clocks at both ends working synchronously, which, by means of revolving cams, place the main wire in consecutive connection with corresponding branches at the two ends for definite times."

In France, too, in connection with railway telegraphy, this class of invention was formerly very popular; and as might be expected, is not neglected by that indefatigable chronicler, the late Count du Moncel, who devotes considerable space to the subject in the *Exposé des Applications de L'Electricité*.[8]

In the plan of Lamothe, for example, which is discussed by M. du Moncel, the gong which is to be struck is by one electromagnet brought within range of a bell hammer, which then by a second electromagnet is caused to strike the bell.

Another inventor, Bizot, has a plan for selectively ringing bells by means of pendulum hammers placed at the different stations, and adjusted at each station to a different length.

An electromagnet at each station in the main circuit controls the swing of the pendulums by its alternate magnetizations and demagnetizations brought about by the makes and breaks of the main line current; these being effected by a vibratory circuit breaker at the transmitter station, operated by a similar electromagnetic pendulum there, which can be adjusted when desired, to the same length as the pendulum at any one of the other stations which it is desired to operate. Only that one to which it is adjusted, will be operated; the others remaining inert. By so arranging *all* of the station pendulums that they can be adjusted, any station is enabled to selectively signal any other.

This apparatus I have described at considerable length, because it is founded on the harmonic principle which later was introduced into telegraphy, and because it contemplates the use in selective signaling of that principle, subsequently more elaborately worked out by German and American inventors and described in their several patents.[9]

Martorey's system, which likewise is described by M. du Moncel, also contains the elements of many subsequent forms. In it, by an electromagnetic step-by-step motion, an escapement wheel having a number of teeth at least equal to the number of stations on the circuit, to give the signal, is brought to a given position by a given number of pulsations, differing for each station. All the teeth are metallic, and all, except one, are insulated.

In addition to the foregoing examples of the condition of the art, it is not, I conceive, out of order to point out that the principles which govern printing telegraphy are closely related also to selective signaling. Consider, for example, the House, Hughes and Phelps telegraphs, and the form of stock quotation recorders now so universally employed; in all of these a given letter or figure is brought to a suitable point and is then pressed by a final operation against the paper to make the impression.

A good stock of knowledge thus was at the disposal of those interested, even at as early a date as 1876, when the career of the telephone was only beginning. We had the electromagnetic ratchet and pawl, step-by-step movement. We had electrically controlled clock-trains.

Why then was it not easy to make at once a thoroughly satisfactory and efficient selective call? One reason is, that the average inventor or would-be inventor generally refuses, tacitly, it is true, to recognize that there is any material of which he may make use. He does not know the state of the art.

From January, 1879, to December, 1891, 161 U. S. patents were granted for forms of Telephonic Selective Signaling appliances, all of which I have examined. A careful analysis shows that quite a large number of general plans have been proposed, and that each of these has been developed in several ways, with greater or less care, and to many degrees of perfection. Several sub-methods can be utilized in many of the general plans, and in a number of cases attempt has been made to provide for several additional functions. Though at one or two points selective signals embodying a few of these different plans are even yet employed, every telephone man knows that it cannot truly be asserted that success has attended such appliances.

DESIRABILITY OF SELECTIVE SIGNALS.

This epigrammatic saying is, however, in some sort losing its attractiveness, in face of the multitude of conductors which it implies; and to a keen observer of the signs of the telephonic times, it is evident that a very extensive return to party lines in some form will, bye and bye, be inevitable; at all events for residential districts, and from this point of view it appears that the demand for a simple and trustworthy, but not costly, selective signal is as great as ever, and that, if such a thing is made, and its merits proved, many more party lines could and would be arranged and satisfactorily operated.

And to aid the adventurer who intends to construct such an apparatus, I will outline the principles upon which this class of work in its several proposed plans have so far been founded, reference being made in brackets to a single U. S. patent exemplifying each of the several plans.

GENERAL PLANS.

1. *To operate the several signals at each sub-station on a circuit with differing strengths of current.*

Bells depending for their proper operation on a margin of current are, however, generally untrustworthy. [U. S. Patent—No. 221,512, Nov. 11, 1879, Buell.]

2. *Signals arranged to respond to currents of opposed direction.*

This implies, of course, polarized bells, and for a line with but two stations, it is probably as good an arrangement as can be provided. [U. S. Patent—No. 218,153, August 5, 1879, Anders.]

3. *Signals involving changes both in strength and direction of currents.*

These are apt to be unreliable for the same reason as are those of No. 1. [Patent No. 242,408, May 31, 1881, Anders and Vail.]

4. *Electromagnetic step-by-step devices, acting to bring the sub-station signals to a ringing point differing for each section, and then to close a local, branch, or shunt circuit, including the local*

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[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, June 6, 7 and 8, 1892.

[2] Br. Patent 12039, January 25, 1848, H. and E. Highton.

[3] Br. Patent 12959, February 7, 1850, E. Highton.

[4] Br. Patent 13427, December 27, 1850, Dering.

[5] Br. Patent 3006, December 1, 1863, Wilde.

[6] Br. Patent 910, March 31, 1865, DeBonneville.

[7] Br. Patent 1801, June 11, 1869, Lyttle.

[8] *Exposé des Applications de L'Electricité*, Vol. iii, 1874, pp. 510–538.

[9] German Patent 1944, Maron, December 5, 1877.
Br. Patent 5078, Blake, December 11, 1879.
U. S. Patent 251,097, Currier, December 20, 1881, and others.

bell, to operate ringing mechanism, or in some way to introduce the bell magnet into the circuit.

Fig. 1, taken from a patent of E. N. Dickerson, Jr., illustrates a ratchet and pawl step-by-step movement operating to close a local circuit in which is placed the bell. Successive pulsations sent from the central station, cause the electromagnet M in the main line circuit to attract its armature *a*, which after each pulsation is pulled back by a suitable spring (not shown).

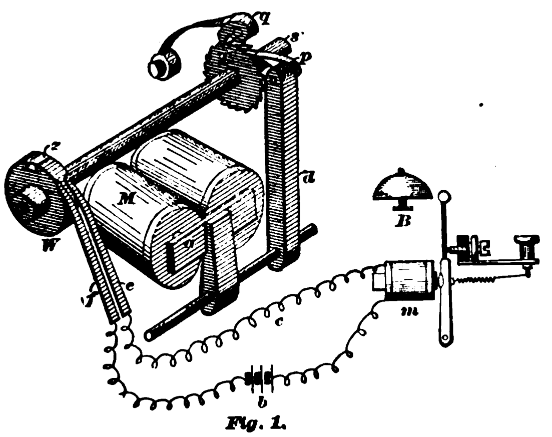

Fig. 1.

The non-conducting wheel *w*, on which presses the two springs *e* and *f*, has at one point on its periphery an inlaid piece of metal *z*. When the wheel is rotated till the plate *z* comes under the two springs, the local circuit of the battery *b* is closed through the bell magnet *m*, and the bell B, which in practice would be vibratory, rings. The wheel *w* can be adjusted on its shaft *s*, so as to be in a different position at each station.

There are of course many other ways of utilizing these principles, one being shown in Fig. 2, which is one of the drawings of a patent taken out by Messrs. Curtis and Crocker.

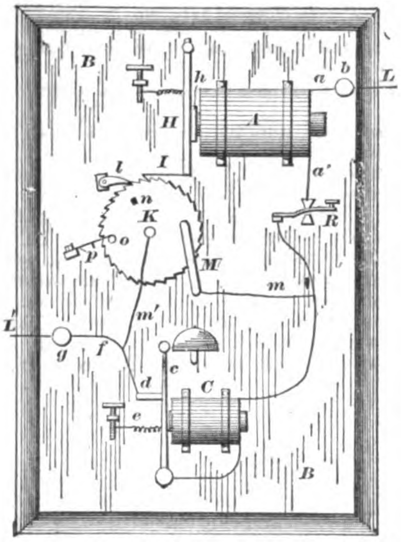

Fig. 2.

This general plan No. 4 has been much favored by inventors, admits of almost indefinite variation, and is easily associated with auxiliary devices such as unisons, busy signals, and lockouts for apparatus at other stations. If mechanism properly designed and made, be employed, there is no reason why satisfactory results might not be expected. Cheap apparatus has however invariably been tried and the system besides is slow. [No. 212,792, March 4, 1879, E. N. Dickerson, Jr. No. 230,530, July 27, 1880, Curtis and Crocker.]

5. *Clockwork Bells.*

a. Those in which a constantly running clock-train brings the bells at the different stations into circuit successively, or removes a mechanical holder from their hammers; when only they can be rung. These are not reliable; it being impossible to keep the clocks together; the clocks also require too frequent winding. [Patent 223,469, January 13, 1880, Bliss.]

b. Those in which at each station is a normally stopped clock-train. All clocks are started by the same initial pulsation, and bring their signals to ringing points, or their bells into circuit at different times.

This idea is one of the most practical that has been advanced, and if the apparatus is well designed, and put together in a good mechanical form, it ought to do good work; unfortunately, first-class apparatus is costly enough to remove the gilt from the economical side of the selective signal.

This plan is indicated by the diagram Fig. 3, in which, however, the clockwork is not shown. In the diagram H is supposed to be the signal transmitting, and S the signal receiving station, at each of which is a metal circuit wheel B, by which in conjunction with the circuit springs *s* and *v*, the bells *b* are, when at rest, short-circuited. At the transmitting station is a circuit-closing key K, a battery V having one pole united to earth or return G, and the other extended to the front contact V' of the key, and a duplicate W, of the several sub-station instruments.

The first pressure of the key through suitable mechanism starts the clock-works at all stations, and introduces the bells at each station successively, as the wheels B bring their notches under the springs *v*. The wheels are in the present instant supposed to be slow moving, and to have six ringing notches for each complete revolution. They can by suitable mechanism be stopped on each notch to ring a given bell as long as may be desired; and they come to rest after one notch at all stations has passed under its spring.

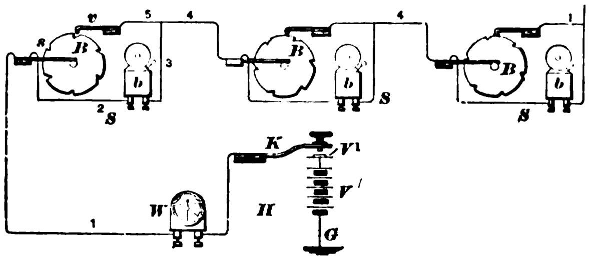

Fig. 3.

Of course the notches are arranged to pass under the springs at different times for the several stations, and this is indicated in the figure, where the bell at the nearest station is introduced into the circuit; the springs *v* of the others being at different positions on the periphery of the wheel. [Patent 232,442, Sept. 21, 1880, Blake.]

c. Those in which a normally quiescent clock-train is controlled by an electromagnetic escapement, and permitted to move by successive beats, as a key at the central station alternately makes and breaks the circuit. [Patent 228,047, May 25, 1880, Eaton.]

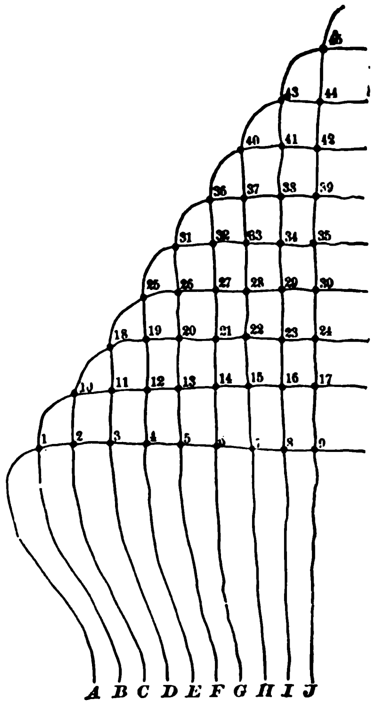

Fig. 4.

This could doubtless be made to work all right by putting excellent apparatus into it, but like nearly all step-by-step devices, would generally be slow.[10]

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[10] All of the subdivisions of class 5, may either have the signaling device directly in the main circuit, or in a local circuit to be closed by the action of the main circuit.

6. *Bells in which all the hammers move forward to strike at the same time, but except the desired one are prevented from striking by an interposed mechanical obstacle, which in the bell of the wanted station is removed.*

This has been faithfully tried. It was operated by an electro-magnetic ratchet and pawl, and was uncertain in operation. It also developed another fault, viz., that even the bells which are not to respond, make a considerable rattling. [Patent No. 219,059, Sept. 2, 1879, Anders.]

7. *Bells in which the ringing is done by circuit arrangement, or conductor combinations. Two series of circuits may radiate from a central to a number of sub-stations, and one of each series caused to enter all stations. No two stations, however, have the same two circuits. Only when the current traverses both circuits does the bell ring at the station they enter.*

This is very promising. It cannot, however, be applied to a multiple switchboard system, It requires relays and a local circuit bell ; but no specially constructed apparatus. It is also very speedy; the single pressure of a given key will always ring a given bell, and no mistake can be made. This system is roughly illustrated by the diagram, Fig. 4, in which each outgoing conductor is shown to intersect each other conductor at some one sub-station, and thus afford facilities for producing a selective signal for 45 stations by using but 10 main lines.

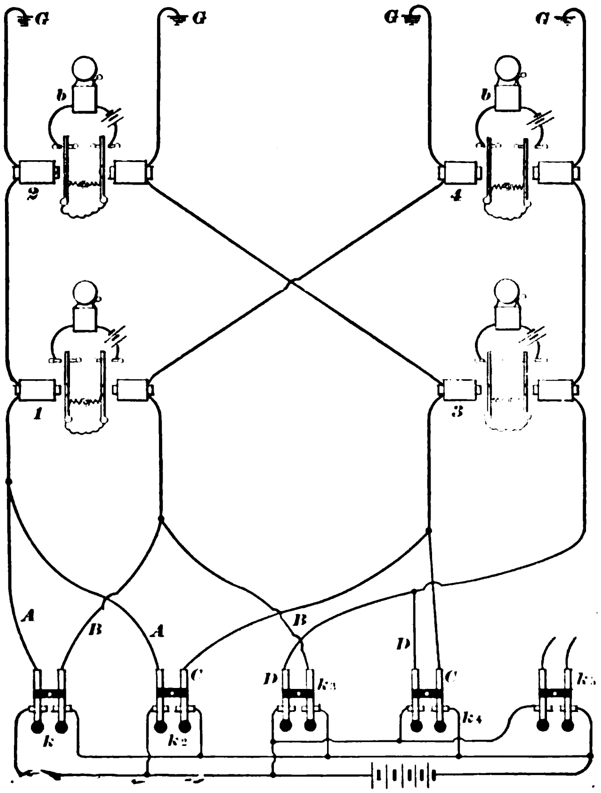

Fig. 5.

For example, if it be desired to signal station 41, it will be necessary to manipulate the lines G and I.

The diagram Fig. 5, more fully illustrates one way in which the idea is worked out, although there are several plans, all of which are more or less advantageous. A battery, B, branches its two poles to each of a series of keys *k*, each of which controls the terminals of two lines; for example, key *k* may control terminals of A and B, k^2 those of A and C, and so on.

At each sub-station two lines both enter and pass respectively through relays, and the concurrent action of the two relays at any station is required to ring the bell, since the bell circuit is led through the armature levers and their front contacts of both.

Taking the conductors in pairs, the number of possible combinations is represented by the expression $\frac{n^2-n}{2}$ and that number of separate stations can be selectively signaled by the use of *n* wires. [Patent No. 219,188, Sept, 2, 1879, Vail; Patent No. 224,855, Feb'y 24, 1880, Vail.]

8. *Bells working on the principles of harmonic telegraphy.* At each station the spring, pendulum or reed carrying the bell hammer is tuned to respond to a different note or rate of vibration.

The central station transmitting device is adjustable, and can have its rate made to correspond with that of any sub-station bell. When set in operation the coinciding bell only will ring. Operated always by experts, and carefully constructed and adjusted, these might do well. They are, however, too sensitive; tend to become operative as their proper number of vibrations is approached, and in some degree become irregular with temperature changes. Fig. 6 illustrates the idea, and shows a central and three sub-stations.

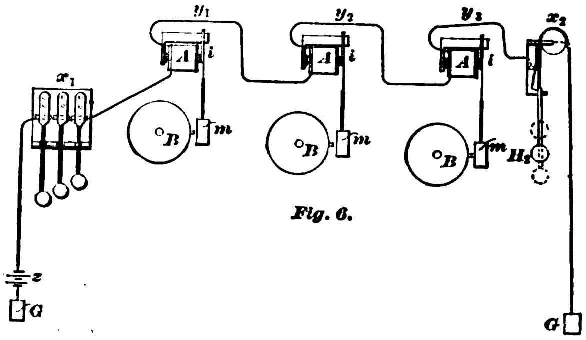

Fig. 6.

9. *Sub-station signals in which galvanometers, identically constructed and calibrated, make the same deflection with a given current; to ring the bells different currents are sent, which produce different deflections. Each, of course, has its ringing deflection at a different point, which may by a mercury cup close a local circuit.*

These signals ought to work fairly well, if sufficient care and cost be put into them. It would not be difficult to add several other classes to this list, but those which have been mentioned are the most important. [Patent No. 262,252, Aug. 8, 1882, Southworth.]

The plans of greatest promise are:

A. Those which by clockwork (as in 5*b*) are brought to a ringing point differing for each, the clockwork being then stopped, and the ringing done by a different kind of current. This is virtually the same plan of operation as is employed in the stock quotation printing telegraphs, and is reliable, but, when adapted to do the work well, costly.

B. Those which as in class 7, require the coaction of two circuits.

Either of these when adopted should be worked in connection with a local battery.

Probably in practice it will be found advantageous to have a separate circuit distinct from the telephone circuit, on which a great number of selective signals may be connected.

The unison or zero device in some form may be considered as an essential auxiliary in all progressive signals, whether of the clockwork or step-by-step orders. Even the most perfect mechanism slips occasionally, and as in the stock printing systems where instruments "throw out" or get out of step with each other, a suitable zero at which all can periodically be brought to rest, and start even, must be certainly required. A "busy" signal which indicates at each station whether the line is in use at any other is useful, but not essential. And lock-out apparatus, usually provided by closing a shunt circuit round the call-sending mechanism and telephones, at all stations on a circuit, except the

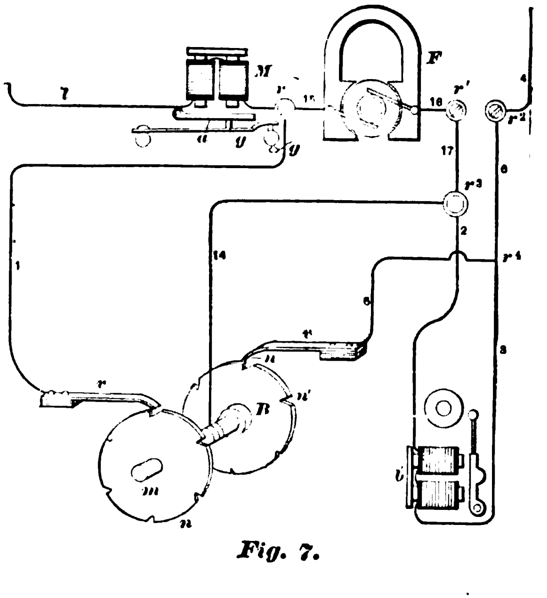

Fig. 7.

one or two which are actually communicating, is also highly advisable in order that privacy and freedom from interruption may be maintained.

But, while some of these devices are necessary, and all useful if reliable, the contriver from this time forward must keep at all times before his eyes, the undoubted fact that selective signals where heretofore tried, have uniformly been handicapped by being too intimately associated with too many such auxiliary devices, and must be correspondingly cautious about the way in which they are added.

Some such mode as is depicted in Fig. 7 is best for this purpose.

In the figure, M is a clock-tripping magnet; F the magneto generator for sending outgoing calls, *b* the station bell, and *m* and *n* two metallic wheel commutators mounted on, and electrically connected with the same shaft B. Arranged to press on the periphery of *m* is a contact spring *v′* and similarly placed with respect to *n*, is a spring *v*.

When the station mechanism is at rest, it is desirable to have the generators in the line circuit, but the bells out. Accordingly, the bell is short-circuited through the disk *n*, spring *v*, and wires 14 and 5; while a possible shunt circuit round the generator through disk *m*, spring *v′*, and wires 1 and 14 is open, the spring *v′* being over the notch. The notches of *m* are placed alike at all stations, but those of *n* differ at all stations; and therefore as soon as the shaft *B* begins to move, when the driving clock-train is tripped, the shunt circuit is established round all the station generators, and no station can interrupt by an attempt to send a call signal.

Such a device is well enough because it can generally be added without at all impeding the operation of the signal proper, and in any case constitutes a perfectly proper adjunct to the equipment of a party line. But when associated with selective signals the greatest care is necessary to provide that the arrangement is such that the auxiliary appliance may not prove a drag on the signaling mechanism.

Selective signals require a fair field and all the favor they can get.

RAILWAY TRAIN LIGHTING.[1]

BY A. H. BAUER.

THE first successful system of railway train lighting is that invented by Houghton, and adopted by the London, Brighton and South Coast Railway of England, in 1881–2. Since then the many improvements suggested by other inventors have made it almost automatic.

The system consists of a Brush dynamo carried inside the baggage compartment, and directly connected by link belting to pulleys on the axle of the car. Attached to the dynamo is a ball governor, rotating vertically, whose office is as follows:

1st. To control the movement of a switch, which, when the speed and therefore the E. M. F. of the dynamo reaches a predetermined value closes the circuit, and also opens it again when the E. M. F. approximates that of the secondary battery.

2d. The adjustment of a resistance which maintains the current constant, and

3d. To shift the position of the brushes as the neutral point is changed by the varying speed of the armature.

But one set of brushes is used, carried in rectangular holders, at right angles to the commutator, and always in contact with it.

When the rotation of the armature is reversed by a change of direction of the train, the brushes are carried forward or backward by the friction on the commutator and a connection with the governor until the quadrant passes but a fraction beyond the vertical, when it is drawn to the proper position by a spring, the action being similar to that of the snap switch. Limiting stops are provided to prevent the quadrant going too far.

The same movement of the quadrant also changes the position of a switch controlling the connection of the field coils, and therefore the polarity of the dynamo. It therefore follows that the current is always in the same direction, no matter in which direction the armature may rotate. One set of accumulators, consisting of 25 cells, is provided for each train, and placed in the baggage compartment. The maximum number of lamps in a train is 70, of 10 c. p. each, at 50 volts. No attendant is necessary, but at certain stations on the line an examination of the plant is made, and required repairs attended to. I am informed the system is so reliable that since the year 1888 but two failures have occurred.

It will be noted that the key of this system is the convenience with which the connection between the armature pulley and that on the axle can be made. Throughout Europe the rigid wheel base is universally employed under railway cars; consequently, by setting the dynamo across the car, the armature shaft will always be parallel with the axle, and the connecting belt runs in practically the same plane.

In this country the bogie truck is exclusively used. Several attempts have been made to drive dynamos by connections with the axle of bogie trucks. All, however, have failed, for the reason that no provision was made for maintaining the armature shaft and axle parallel at all angles of the truck, and because sand, dirt, etc., gathered by a moving truck will soon destroy any mechanism that may be used for the purpose under the car. The problem, however, has not been abandoned, and I am in hopes that within a very short time a solution will be found.

Numerous propositions have been made to use primary batteries for car lighting, but I am not informed of a successful installation of that character.

Secondary or storage batteries have been more or less employed for the purpose, with varying success. The first attempt in this direction was made in 1887–8 on two Pullman limited trains of six cars each. Each car was equipped with 30 cells of battery, having a capacity of 150 ampere hours, and weighing 50 pounds per cell, or 1,500 pounds per car. Duplicate sets were kept charged at each end of the line, and, on arrival of the train, exchanged for those that had been exhausted while on the road. The average number of lamps per car was 26, of 16 c. p., at 60 volts, or a total of 156 in the train. After 60 days' trial, it was clearly demonstrated that, under existing conditions, the system could not be made successful, and it was abandoned.

The reasons for its failure were that the capacity of the battery was insufficient to maintain the number of lamps required for the proper lighting of Pullman cars on long runs.

A second reason was the deterioration of the batteries themselves, which were of the pasted grid type. Close observation indicated the loss during one handling to be equal to, if not more, than that caused by 1,000 miles of travel on the car. This was five years ago. Since then, improved methods of manufacture, as well as more intelligent care in handling, has, to a great extent, overcome their objections and thereby increased the life of the battery.

Since these experiments were made, car lighting for short distance, only, from storage batteries, has been made successful. For the past two years four cars, each equipped with 32 cells of 150 ampere hours capacity and 26 16-c. p. 60-volt lamps have been running between Chicago and Cincinnati, and Chicago and Indianapolis. Two of these cars are charged every day at Chicago for about nine hours with sufficient current for a round trip. The batteries, however, are not changed; the cars are always placed on the same side track to which wires from the dynamo are led, and the charging is done without removing them. The average length of time the light is required during a round trip is six hours; the cars leave each end of the line at 8 and 9 p. m. respectively. Repairs are made by removing the defective cell and substituting another if necessary.

The cost of repairs and renewals of all kinds from September, 1891, to January, 1892, inclusive, per month, was as follows:

September, 1891	$36.44
October, "	108.82
November, "	51.24
December, "	79.21
January, 1892	38.31
Total	$314.02

which, divided by four, is $78.50 per car per month, or $2.61 per car per day, and this divided by 26 gives 10 cents as the cost per lamp per day. As the engine and boiler are used for furnishing power for other purposes while running the charging dynamo, it is difficult to get the cost of the power for charging these batteries, that factor, therefore, is not included in the above statement.

In January, 1888, a solution of the problem of lighting six-car trains for long distances was sought for in another direction. Two trains running between Jersey City and Jacksonville, Florida, a distance of 1,100 miles, were selected for the experiment. At first an attempt was made to utilize the power of the axle, but for reasons already stated did not prove successful.

The next step was the substitution of a vertical single-stroke engine, located in the baggage car, for the axle connection.

The system which has been used for the past five years on all Pullman trains, consists of a Brotherhood three-cylinder engine and Eickemeyer dynamo, bolted to a cast-iron bed-plate, and located in the forward end of the baggage car, occupying an enclosed space of 6 feet 6 inches by 3 feet 3 inches. The engine and dynamo are connected by a flexible coupling which allows for the irregularity should they not be in perfect line. A two-gallon sight-feed pressure lubricator bolted to the end of the car, furnishes oil to all wearing parts of the engine. The average consumption of oil is about one gallon every 20 hours of actual running of the engine.

Steam is taken from the locomotive boiler, a tap being made at the dome, the pipe passing under the tender and car, between which a flexible rubber hose makes connection. With 50 pounds pressure, the dynamo will, at 900 revolutions, generate 80 amperes, at 72 volts, when all the lamps and batteries in a six-car train are in circuit; and 50 to 75 amperes, at 80 to 85 volts, at the same speed when the batteries alone are connected, depending on the counter E. M. F. of the batteries.

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[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, Ill., June 6, 7 and 8, 1892.

On the side of the car is placed an automatic switch, which will break the circuit when the E. M. F. of the dynamo equals that of the batteries. A voltmeter and ammeter are kept constantly in circuit while the plant is in operation. A tachometer, belted to the armature shaft, is also provided for noting the speed of the engine and dynamo. This plant is enclosed by a tongue-and-groove partition surmounted by a wire screen.

The system of wiring adopted is the equi-potential, in which the pressure is practically equal at each lamp and battery. A third wire leads from the negative pole of the dynamo to the rear end of the rear car, where it ends. This third wire is tapped to the negative pole of each battery and the remaining side of each lamp. The wires are always placed on the roof of a car. For this purpose whitewood mouldings, thickly coated with asphalt paint, is nailed from end to end as near the centre as possible, usually $1\frac{3}{4}$ inch from the edge of the smoke-jack if the car is equipped with centre oil lamps, and from 6 to 24 inches when gas lamps are applied.

The sizes of wire used are all of B. & S. gauge, and consist of No. 2 for those leading from the dynamo, Nos. 6 and 10 for the lamp mains and No. 14 for the lamp drops. The connection between cars is made by bringing the wires from the roof through the hood to the inside of the vestibule, where they terminate in square brass tubing called connectors, which are permanently attached to the vestibule frame. The connection between these connectors is made with three-conductor flexible cables, each conductor of No. 6 gauge.

When the batteries alone are in circuit, the E. M. F. of the dynamo will be from 67 to 83 volts, which, minus the loss, will overcome the counter E. M. F. of the batteries, viz., 57.6 to 73.6 volts. When both lamps and batteries are in circuit the external resistance is of course reduced and the E. M. F. of the dynamo falls in proportion, and that at the lamps will be from 60 to 66 volts.

Each car is provided with 32 cells of storage batteries, placed 16 in each of two boxes, securely fastened under the centre, and directly over the truss rod. The weight of batteries and boxes complete, is about 2,000 pounds. As already stated, with the system of wiring adopted the batteries and lamps are permanently connected in multiple arc, so that should the train be parted and connection with the dynamo become broken the batteries will supply current necessary to maintain the light; or should the batteries under one car become disconnected, its lamps will be supplied from batteries under other cars in the train.

The lamp equipment of a six-car Pullman train is as follows:

Combined smoking and baggage car	21 lamps.
Dining car	32 "
Three sleeping cars	90 "
Combined observation and sleeping car	29 "
Total	172 lamps.

Of this number, 98 are 16 c. p. and 74 are 8 c. p. The latter are placed in hallways, toilet-rooms and vestibules. During six months of the year, seven $\frac{1}{8}$ h. p. fan motors are added, viz., three in the dining, two in the smoking and two in the observation cars, each absorbing the current of four 16 c. p. lamps, or a total of 28, which, added to the 172, makes the total, 200 lamps in the train. To maintain the 200 lamps requires 144 amperes. As the dynamo will generate but 80, the batteries must supply 64 amperes, or 44 per cent. This is effected by charging the batteries during the day and part of the night *en route*, and while the train is standing in the yards.

The following, taken from the January records of a train, will give an idea of the number of lamp hours required:

CHICAGO TO JERSEY CITY.

Time.	Hours.	No. of lamps.	Lamp hours.	
4 A. M. to 9 P. M.	5	172	860	Leaving Chicago.
9 " 11 "	2	140	280	
11 " 12 "	1	42	42	
4 " 7 "	3	172	516	Arriving at Jersey City.
During day in tunnels and depots	1	172	172	
Total			1,870	

JERSEY CITY TO CHICAGO.

Time.	Hours.	No. of lamps.	Lamp hours.	
4 P. M. to 9:30 P. M.	5½	172	946	Leaving Jersey City.
9:30 " 11 "	1½	140	210	
11 " 12 "	1	42	42	
6 A. M. to 7:30 A. M.	1½	32	48	Arriving at Chicago.
During day in tunnels and depots	1	172	172	
Total			1,418	

Total, 3,288 lamp hours during the round trip.

The cost of an installation for a six-car Pullman train—consisting of one combined baggage and smoking, three sleeping, one dining and one combined sleeping and observation car is $5,808.20, or an average of $968.00 per car. As the fan motors are used but six months in the year, the average number of lamps will be 172 + 14 = 186. Therefore, the cost of equipment per lamp will be $5,808.26 ÷ 186 = $31.22.

The average cost of labor and material for maintaining the lighting of three trains, or 18 cars for 19 months, from August, 1890, to February, 1892, inclusive, was as follows:

Average total cost per month			$1,265.95
"	"	per car per day	1.99
"	"	of labor per month	712.39
"	"	" per car per day	1.11
"	"	of material per month	511.51
"	"	" per car per day	87
"	"	per lamp per day	07.17
Average number of lamps in use			558

The item of labor includes the wages of five attendants on the train, at $3.00 per day each, and two men at each terminal station, at $90.00 and $55.00, and $75.00 and $50.00 per month respectively. That of material includes the cost of renewal of batteries, etc.

The cost of labor is practically constant, while that of material varies from 12 cents to $2.04 per car per day, the average for 19 months being 87 cents. The cost per lamp per day varies from $3\frac{8}{10}$ cents to $12\frac{5}{10}$ cents; the average is 7.17 cents.

The cost of power furnished by the locomotive boiler is not included in the statement, for the reason that a satisfactory measurement of the quantity of coal and water used has never been made.

So long as the dynamo can be run, and the batteries properly charged, the system is reliable.

During the coldest part of the winter, or as sometimes happens, when a poor quality of coal is furnished, it is difficult for the locomotive to supply sufficient steam to run the dynamo. In such cases the batteries are called upon to maintain the light. As a rule, they have sufficient charge to do so for about four hours. Trains so equipped have been run between Jersey City and St. Augustine, Florida, during the months of January, February, March and April of each year since 1888. The system has also been used on other trains, viz., between New Orleans and the City of Mexico, Omaha and San Francisco, Chicago and Portland, Me.

It was early seen that the only uncertainty connected with the system is due to the absolute dependence upon the locomotive boiler for power to run the dynamo, for, as explained, there is a constant liability of the failure of the steam supply which, if prolonged beyond the capacity of the battery will result in the use of oil or gas for light. As many other problems connected with the system have been successfully worked out, it is believed that the solution of this one will also be found.

There is no doubt that the ideal way of running the dynamo is by a connection with the axle. Many apparent solutions have been suggested, only to be condemned as uncertain or impracticable. It is, however, thought that within the next year a reliable connection will be had, after which I believe the lighting of railway trains by electricity will be universally adopted.

SOME POINTS FOR THE ELECTRICAL ENGINEER.[1]

BY HORATIO A. FOSTER.

It has been the fortune of the writer during the last 10 months to visit and inspect, both technically and financially, considerably more than a hundred central lighting stations. Taken as a whole, it really seems as if much of the ordinary commercial common sense and the usual keen judgment of self-interest had been on a vacation when these plants were erected.

So much diversity of opinion is shown in designing these stations, and oftentimes by those whose opinion should have no weight, but unfortunately does, that it has the effect to convince some of the investing public that the electrical engineer does not know his business and they might as well go it alone. If some action could be taken by this Institute through a committee which should examine into proper station design and report on some few general plans and suggestions as to lines to be followed, it might go far toward establishing a better backing for our members who are in that branch.

Quite often officials of the electric lighting companies take a jaunt through the country visiting different stations for models for a new one for themselves. This often results in a worse muddle than ever, as they seldom find two stations at all similar, and they return resolved to use their own judgment. This leaves the real electrical engineer out in the cold, at a point where, if known, he could by consultation do much good; but many of these company officials never heard of the American Institute of Electrical Engineers and need to have it brought to their notice in some way. Perhaps if instances be mentioned under the folwing heads a better understanding can be arrived at, viz.: cation ; foundations ; construction of station ; motive power ; rangement of machinery, and location and construction of lines.

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[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, Ill., June 6, 7 and 8, 1892.

Location.—The location of plants is not now so generally bad as in the past, although we occasionally find a station in a location for which no excuse is apparent, as, for instance, one located in the basement of a carpenter shop at a long distance from fuel supplies, and only plenty of condensing water to recommend it ; insurance rate, three per cent. or more. Another located nine miles away from a village of 2,000 people to take advantage of water-power never surely available all the year, and since destroyed entirely for the greater part of the year.

One advantage of some of the older centrally located stations has since been learned in the increase in value of such real estate. One such station visited will enlarge and rebuild soon, and will sell its present real estate for enough advance to go far toward paying for the new station, and there are others which can, I think, tell the same story. In fact, in the present problematical growth of the future, a well-selected piece of ground may prove a very valuable part of the investment.

Foundations.—Foundations are now much better than in the past, and some of those now placed under dynamos would sustain almost anything that could be put on them. Poor foundations are occasionally seen though, as for instance those under a large bank of boilers in a station which was erected and started in six weeks. The boilers have since lurched forward until the fronts are some two or three inches out of plumb. In fact too little attention seems to have been paid to boiler foundations as a general thing. Engines have fared better and when the ground has been good the foundations are to be little criticised.

Very few bad dynamo foundations are now met, but many unbalanced armatures are found which no amount of foundation would hold steady.

Station Construction.—In station construction there has been no settled design, therefore the promoters have generally built as they saw fit, occasionally following suggestions of the agent. Of course many plants are located in buildings already up, in which case the machinery had to be made to fit.

In many of those built especially for the work, no attention has been paid to designing for a low insurance rate, and brick stations are found sheathed all over the inside with pine, the one thing that insurance inspectors always criticise. A couple of coatings of whitewash or paint would have been much cheaper, safer, and looked quite as well.

When stations have been remodeled, very little improvement has been made in the smaller ones, but those in large cities have generally taken advantage of all the improvements to date, if not too strongly attached to some one parent company.

Motive Power.—The selection of motive power has of course been governed by local conditions; in the northern and northwestern part of New York State, water-power is abundant and is largely used as motive power for stations, but almost invariably with steam reserve. Water-power alone has been found very difficult to govern for uniform speed, and some of the devices used for that purpose are, to say the least, ingenious.

Of engines there is no end to the different design, style and size used. Some use high speed, belted direct to dynamos, others slow speed belted to counter, some simple non-condensing where compound condensing would be decidedly best. I know of at least three plants located in water-works pumping stations, using high speed simple non-condensing engines on a practically steady load, all of which have been erected during the past three or four years.

Two stations I remember having an all-night and every-night load of arc lights and situated on a lake shore which run high speed simple non-condensing engines.

To offset this there is one station that deserves mention as it embodies many points of value. The building is substantial, of brick, two stories high and on a river bank. The boilers are very efficient and well set, the engine is a moderate speed compound condensing, with shaft extended for three dynamo pulleys, and one for the power condenser. There is a heater between the exhaust and condenser and a power pump attached to one side of the condenser. The flow to the boilers is governed by a bye-pass valve, as the pump is of course in motion all the time the engine is running. This station has only an arc load and runs all night; it was built entirely under the supervision of a local mechanical engineer with the exception of connecting the lines and dynamo terminals to the switchboard, and would, I think, be hard to beat for results.

Arrangement of Machinery.—The arrangement of machinery is as diverse as the style of motive power; when direct belting is used the arrangement is generally simple and plain, but oftentimes so crowded as to be very inconvenient.

There seems no end to the arrangement of shafting; some have a line shaft through the middle of the dynamo-room and belt both ways to dynamos, others a shaft on either side of the room belting to dynamos in the centre, others the shaft under the floor belting up to dynamos and occasionally to engines also, others have the shafting overhead; in fact, there is no end to the styles, some good and some bad. In most cases friction clutches are used with shafting for stopping individual dynamos and some few may use loose pulleys on independent sleeve for the same purpose.

The length of belt centres varies greatly, some apparently thinking if long belts are better than short, very long ones must be much the best.

The improvement in switchboards seems to me more marked than in any other one department, which is probably owing to the pressure of insurance men who look at the switchboard as the most dangerous fire risk of all.

Line Construction.—In line construction I cannot see that any very marked improvement has been made, excepting in some cases, the substitution of larger and better poles for the older ones. The use of black-covered wire in place of white has perhaps made the lines a trifle less conspicuous but that is about all. The lines still have the apparent aimlessness of direction mentioned by Prof. Thomson at Buffalo. People in the larger interior cities are already agitating the question of underground wires and it seems probable that unless something is done soon by the companies themselves to rid the streets of the more conspicuous of these wires, there will be very costly trouble for them to contend with.

In street lighting the favorite method is the cable suspension across the street. Where the work is neatly done this serves very well but it would be difficult to find a more unsightly thing than some of the lamps so suspended. Considerable trouble is occasioned in the above method by breakage of the wires at the joint with the line and at the cross-bar over the hood. There is no apparent reason why twin or duplex wire should not be more used for this purpose, instead of the kinked and straggly single wires.

It seems to me that if some action was taken by a non-partisan association like this Institute, an advance toward better engineering might be made, if a few general laws could be suggested to be followed in laying out the different parts of a lighting station. Perhaps it may be said that much of the above work should more properly come before the National Electric Light Association, but as many of that society are members of this Institute, I feel sure they would individually appreciate its backing in the future when the time comes for enlargement, and they have need of combined expert opinion.

Society and Club Notes.

PROF. E. J. HOUSTON BEFORE THE BROOKLYN INSTITUTE.

A MOST interesting, instructive and suggestive lecture was delivered on Wednesday, June 1, before the Electrical Section of the Brooklyn Institute, by Prof. E. J. Houston, on "The Advance of Electricity During the Last Hundred Years." In addition to reviewing the work done in various departments of electrical science and application, Prof. Houston touched on many points of importance concerning all branches of invention and discovery. Great ideas or inventions can be arranged he said, under three great types or classes, viz : 1. Immature or incomplete ; 2. Mature but unripe ; 3. Ripe. Ideas or inventions of the first type produce but little effect in the world—at times, however, they tend to direct thought to certain channels and thus act as forerunners of greater and more valuable ideas. Ideas of the second type are mature, but the times are unripe for them ; the condition of the environment is unsuited, and therefore, though matured and complete in themselves, like unripe fruit they produce no progeny for the development of the world.

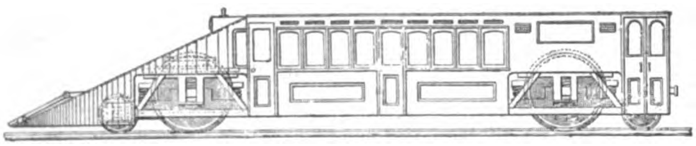
Ideas or inventions of the third type are of far greater value to the world than those of the second type, since they bear fruit almost immediately. It matters little to the world whether they have been conceived before or not. When practicable, they must necessarily find birth or creation as soon as the times are ripe for them. The fact that such ideas are subsequently found to be old ones does not prevent them from being original with their later producer. As to this class of inventions, if the world is ripe and ready to receive them, it may happen that they may be made in different parts of the world at about the same time. Prof. Youmans expresses it as his opinion that great ideas belong to eras rather than to individuals ; that intellectual progress may move in waves toward the boundaries of the unknown, and many investigators moving with that wave may, at very nearly the same time, discover new features and facts on the horizon beyond.

Prof. Houston went on to show how most if not all of the great electrical industries had passed through these stages, and how one invention sprang from another. He predicted that as the result of what had already been seen and done, the near future would enjoy a cheaper means of producing electricity than the present dynamo-electric machine ; the entire replacement of the steam engine by the electric motor ; the solution of the problem of aerial navigation by means of electricity ; the substitution of the present electric light by other forms of the kind exhibited by Nikola Tesla, and a more intelligent therapeutical application of the electric current.

"FROM CHICAGO TO ST. LOUIS BY ELECTRIC EXPRESS."

UNDER the above title a very striking address was delivered at the New York Electric Club, on Thursday evening, June 2d, by Dr. Wellington Adams, of St. Louis, with the help of a number of lantern slides illustrative of the line of road and the apparatus which it is proposed to use. The road is to be 248 miles long and will be absolutely straight except where it curves into the cities of St. Louis and Chicago. For at least 200 miles the country is as level as a billiard table, and the worst grade on the whole line does not exceed two per cent. There will be two main tracks, and later other parallel tracks are to be built for trains that are not through expresses. The road-bed will be drained, will have a ditch on each side, and will be laid with 70-pound overlapping rail, so making a continuous circuit. Between the two road-beds or tracks will be centre poles carrying the trolley wires to supply the current, and the line will be divided up into ten-mile sections, so that the service wire on each will deliver an alternating current of 100 amperes at 3,000 volts. Current is to be fed into the primary line from two generating stations and raised to 25,000 volts and then lowered to 3,000 by a converter for each section. There are to be two generating stations along the line, one about 60 miles from Chicago utilizing a water-fall of 10,000 h. p. and the other at a coal mine at Edinburg, about the same distance from St. Louis These are each, therefore, equidistant from the terminals and will take care of an equal part of the line on each side of them.

The service of transportation will be done by means of individual motor cars of the type shown in the accompanying engraving. Each car will weigh about 15 tons. The roof will be only nine feet above the rails. The driving wheels will be six feet in diameter, and on the bogie truck at each end of the car, driving directly, will be a 200 h. p. alternating current motor, apparently of the synchronous type. Each motor will weigh 6,130 pounds and give 200 h. p at 500 revolutions per minute. Forty passengers and mail and express matter can be carried. There will be a pilot wheel in front and one at the rear. The forward end of the car is cone-shaped to lessen the atmospheric resistance. The one driver and attendant stands in the front compartment. He is to do everything including the collection of tickets. The trolley arrangement is to consist of two sliding shoe contacts, between which is a 12-inch wheel maintaining touch with the line. The trolley wire will be but slightly above the roof of the car and is to be so carried by poles and suspensions as not to sag.



ADAMS HIGH-SPEED MOTOR CAR.

The cost of the road is placed at $6,000,000. Over 60 per cent. of the right of way has already been secured. The company counts on getting its road ready in time for the World's Fair and on carrying there 3,000,000 passengers at $5 each for the round trip. At present there are 1,200 through passengers between Chicago and St. Louis daily, and the carriage of the mails pays $105,000 per annum. The proposed running time will be 2½ hours as compared with 8½ as at present.

After the lecture, Mr. G. M. Phelps, who presided, asked for a discussion of the daring project thus unfolded. Mr. O. T. Crosby and Prof. George Forbes were both of a rather doubtful and misgiving state of mind, and while they wished Dr. Adams success, they seemed to question the practicability of his schemes. Dr. Adams said in conclusion that he could not, for reasons as to patents, etc., go into further details of his proposed apparatus.

CHICAGO ELECTRICAL ASSOCIATION.

THE meeting on June 14th will be held at Atheneum Hall, 28 Van Buren street, where Mr. George Cutter will have facilities for an illustrated lecture on "Thomson's Induction Experiments." The principles underlying the modern applications of the alternating current are now widely known, yet comparatively few have seen the interesting experiments devised by Prof. Elihu Thomson. Mr. Cutter has built apparatus for repeating many of these, and will also show a number of new experiments bearing on the same lines. All interested will be welcomed by the association.

THE COMMISSIONERS OF THE DISTRICT OF COLUMBIA recently gave notice that all the theatres of Washington must be fitted throughout with electric lights.

Literature.

American Telegraphy: Systems, Apparatus, Operation. By William Maver, Jr., Electrician Consolidated Telegraph and Electrical Subway Company; Ex-Electrician Baltimore and Ohio Telegraph Company, etc. With 450 illustrations. *New York*, 1892. J. H. Bunnell & Co. Large 8vo, pp. xvi + 574. Price $5.00.

ALTHOUGH MR. MAVER has chosen a comprehensive title for his work, it may be truthfully said that his treatment of the subject has been no less comprehensive than the title indicates. In his introductory chapter the author tells us that in its modern signification, the word "telegraph" embraces "any means whereby intelligence is conveyed to a distance by signs or sounds," and it is from this generic standpoint that he has chosen to deal with the subject of American telegraphy. Of the vast expenditure of labor and time required to accomplish such a result in an adequate manner, no person unfamiliar with the field of applied electricity as it exists to-day can form the slightest conception. Whether it was worth while to undertake to embody the results of such a wide research within the limits of a single volume is a question which it is perhaps unnecessary for us to discuss; but it can scarcely be gainsaid that not only the electrical industries in general, but even that department of them relating exclusively to telegraphy, using the word in its broadest sense, have become so largely specialized by the rapid and diverse progress of invention and application, that it is no longer possible for any one person to hope to become an adept in every branch of the art. Accordingly, we see in later years a marked tendency towards the production of books in which the author has confined himself to an attempt to treat exhaustively some special branch of the art; books of which Kempe's "Handbook of Testing" and Douglas's "Telegraphic Construction" may be mentioned as examples. But standing as we do to day, in a certain sense, at the parting of the ways between the old and the new, it is at all events not to be regretted that one so exceptionally well qualified for the task as Mr. Maver should have undertaken a minute and detailed survey of the entire field, so that all who come after may be enabled to know, in the language of the technical expert, the precise "state of the art" as it existed in A. D. 1892.

Of the 574 large pages of text of Mr. Maver's work, approximately one-half is devoted to a description of the standard Morse telegraphic apparatus in its various modern commercial applications, together with the innumerable details having to do with its installation and practical management. In the remaining portion of the work, the author has managed to find room to discuss almost every form of apparatus known or used in the United States for the communication of intelligence to a distance by means of electricity. In telegraphy proper for example, we find the submarine, automatic, autographic, typographic, and synchronous multiplex. Then we have the numerous special systems for communicating alarms and signals, such as the time-service, the district messenger call, the fire-alarm, the municipal or police service, the railway block systems, the burglar alarm, and so on. There are also special chapters devoted to subterranean and subaqueous lines and cables; and the construction and maintenance of land lines, together with examples of specifications of apparatus and material, and a variety of useful tables of the weight and dimensions of commercial wires, and other cognate matter.

It must by no means be inferred, from what has been said as to the extended scope of Mr. Maver's work, that the several systems and apparatus referred to have failed to receive adequate individual treatment at his hands. On the contrary, if any error has been committed, we should be inclined to say that it is rather in the opposite direction, that of over-elaboration. The author's strong point evidently lies in his thorough mastery of the minutiæ of the every-day working of electrical apparatus, and his unusual capacity for taking infinite pains in the conscientious explanation of what each instrument does, how it does it and why it does it. This predilection for detail, combined with a certain distaste or lack of capacity for generalization which is apparently inherent in the mental constitution of the author, gives to the work an encyclopædic character, which, while not in the least detracting from its merits as a book of reference, nevertheless may possibly tend to render it somewhat tedious to the general scientific reader.

Keeping in mind these limitations, which, after all, have reference only to the general plan and scope of the work, the execution may fairly be said to deserve almost unqualified praise. The descriptive matter, though often couched in somewhat unconventional language, is clear and accurate, and the illustrations, nearly all of which are apparently drawn from the author's own sketches, are abundant, and what is better, are really illustrative. It would not be easy to find, throughout the whole range of electrical literature, more satisfactory examples of illustrative diagrams than those, for instance, on p. 24 explanatory of E M. F., or that on p. 222 showing the distribution of potentials in the Field quadruplex transmitter.

Mr. Maver has long been acknowledged to be a specially well-qualified expert in duplex and quadruplex apparatus, and accordingly the portion of the work relating to this subject is, as might have been expected, of unusual value to those having to do with these systems in ordinary practice. One cannot but be amazed at the marvelous flexibility of the quadruplex system, and the facility with which it lends itself to an infinite variety of special adaptations to meet the wants of the diversified service of the present day. A couple of dozen, more or less, of these modifications are described and figured, and these are obviously but types of many others that may readily be devised by the skilled quadruplex expert, whenever an exigency arises requiring it to be done.

Many special systems and pieces of apparatus of recent origin are described in this work, which may be sought for elsewhere in vain. In short, in spite of its somewhat unsystematic arrangement—a defect which is largely remedied by an excellent index—this treatise will be found to furnish a solution to no small share of the perplexing problems which continually arise in the every-day service of the telegraph.

We wish we might conscientiously praise the publisher's work as highly as we can that of the author, but a strict regard for truth compels us to express the opinion that the size and shape of the pages are inconvenient and awkward, and that the typography throughout is a conspicuous example of a certain indescribable lack of "style" which characterizes the productions of the rural printery; an odd jumble of different styles of captions; mixed fonts of type in the same caption; eccentricities of spelling which have passed undetected by the proof-reader, and so on. The excellence of the subject-matter, and especially of the numerous, beautiful and costly illustrations, might certainly have justified a far more elegant setting. Perhaps a desire to put the book within the reach of every operator, as shown by the price, may excuse this. But these minor blemishes, after all, detract but little from the solid merits of a work which must long remain a monument of the conscientious industry, unfailing grasp of his subject and painstaking fidelity of its author.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 24, 1892.

Accumulators :—

Manufacture of Electrodes for Secondary Batteries, J. F. McLaughlin, 475,535. Filed Jan. 31, 1890.

Relates to the method of applying the active material to the electrode supports and also in the formation of the electrode.

Alarms and Signals :—

Electric Signaling Apparatus, W. C. Moore, 475,334. Filed June 19, 1891.

An improvement in individual call apparatus.

Automatic Electric Alarm, F. S. Palmer and L. H. Delisle, 475,340. Filed Jan. 9, 1892.

An automatic heat alarm for journal bearings.

Conductors, Conduits and Insulators :—

Anti-Inductive Conductor, B. H. Wesslau, 475,648. Filed Jan. 21, 1892.

Employs an open net-work of threads of insulating material with air spaces between them and an outer envelope of insulating material covering the whole.

Dynamos and Motors :—

Commutator Brush, C. L. Coffin, 475,668. Filed Sept. 5, 1891.

A commutator brush consisting of strips of perforated sheet metal.

Lamps and Appurtenances :—

Electric Arc Lamp, L. Brianne, 475,289. Filed July 28, 1891.

A combination with a solenoid traversed by derived current of a movable armature sector, fly-wheel and rack.

Electric Arc Lamp, R. S. Dobbie, 475,544. Filed June 11, 1891.

An arrangement for increasing the intensity of an arc light by localizing the heat of the arc and for preventing the obstruction of the light by the gases produced by the arc.

System of Electric Lighting, M. J. Cowgill, 475,538. Filed Oct. 22, 1891.

A lighting system using a current of greater voltage than the rated voltage of the lamps which current is periodically forced through the circuit.

Incandescent Lamp Socket, C. A. B. Halvorson, 475,555. Filed Aug. 5, 1891.

A lamp socket adapted to be used interchangeably upon the various forms of incandescent lamps.

Electric Arc Lamp, J. E. Gaston, 475,727. Filed Sept. 4, 1891.

Has for its object to increase the reflecting power of electric head-lights and to simplify their construction.

Incandescent Electric Lamp, H. B. Meech, 475,698. Filed Nov. 10, 1890.

A series of incandescent lamps enclosed in a reflecting globe.

Incandescent Lamp Socket, F. C. Rockwell, 475,345. Filed Feb. 24, 1892.

A very cheap keyless socket attached directly to the lamp globe.

Incandescent Electric Lamp, H. Green, 475,391. Filed Aug. 22, 1891.

So constructed that a circuit may be formed with the filament through conductors in a recess in the neck of the lamp, without the aid of filling, etc.

Measurement :—

Electric Meter, A. G. McKenna and H. T. Weed, 475,411. Filed July 14, 1891.

Consists of an electrolytic meter-cell containing mercurial salt and having electrodes and receptacles for catching the deposited mercury.

Electric Actuator for Registering Mechanism, C. F. Holt, 475,393. Filed June 22, 1891.

Metal-Working :—

Device for Heating Metal Rods, A. D. Williamson, 475,651. Filed May 24, 1892.

An arrangement for electrically heating metal rods, etc., in close proximity with the tools employed in working them.

Hoop Welding Apparatus, C. L. Coffin, 475,667. Filed Apr. 25, 1891.

Miscellaneous :—

Electric Mechanism for Reciprocating Motion, H. S. McCay, 475,410. Filed Aug. 20, 1891.

Particularly adapted to drills or stone-cutting tools in which the armature is attached directly to the tool stock.

Coin-Controlled Electrical Apparatus, H. Wickham, 475,527. Filed Dec. 11, 1891.

Rheostat, C. Willms, 475,528. Filed Jan. 14, 1892.

Employs an adhesive resistance material containing finely divided conductive material and metal filings or the like.

Rheostat, C. Willms, 475,529. Filed Jan. 14, 1892.

Similar to 475,528.

Automatic Electric Time Check, C. K. Jardine, 475,566. Filed Dec. 10, 1891.

Claim 3 follows:

In an automatic time check the combination with the deflector of an electromagnet for operating the same and a clock provided with a circuit closer for operating the magnet.

Lightning Arrester, A. G. Waterhouse, 475,645. Filed Dec. 18, 1891.

A lightning arrester composed of three stationary flash plates, two connected at different points to the main circuit and the third to earth.

Cable Hanger, J. J. Nate, 475,600. Filed May 24, 1892.

Consists of a hook having a base which holds wires adapted to pass around the cable for the purpose of suspension.

Sealing Device, C. Cuttriss, 475,442. Filed Mar. 5, 1892.

A device for electrically melting sealing wax.

Amalgamator, J. M. Thompson, 475,360. Filed Jan. 12, 1891.

Lightning Arrester, J. E. Browne and F. H. Tidman, 475,482. Filed July 10, 1889.

A swinging ball lightning arrester.

Electrically Heated Sandbox, L. E. Pease, 475,703. Filed Nov. 16, 1891.

Railways and Appliances :—

Trolley for Electric Railways, J. W. Newhouse. 475,467. Filed Nov. 14, 1891.

Employs a housing intended to more firmly secure the trolley wheel and hold the ends of the shaft.

Switch for Overhead Wires, A. O. Hoyt & P. W. Leffler, 475,504. Filed Sept. 10, 1891.

Comprises a pair of discs detachably connected and each bearing a pair of opposite rail arms, constituting the trolley guide.

Electric Car Lighting System, J. F. McElroy, 475,514. Filed Dec. 19, 1891.

A system of car lighting by means of a dynamo operated by the motion of the car.

Station Indicator, R. B. Ayers, 475,378. Filed Dec. 3, 1891.

Station indicator designed to economize power and space.

Electric Locomotive, T. A. Edison, 475,491. Filed June 3, 1880.

Consists of a complete electromagnetic railway system embracing the generation, distribution and utilization of currents as motive power.

Electric Locomotive, T. A. Edison, 475,492. Filed June 9, 1880.

Electric motor for railways employing a supplemental grooved traction wheel adapted to grip the track.

Electric Locomotive, T. A. Edison, 475,493. Filed June 9, 1880.

A motor in combination with two derived circuits one including the rotating armature and the other the coils of the field magnet.

Electric Railway, T. A. Edison, 475,494. Filed June 3, 1880.

Claim 3 follows:

Combination with a section of main conductors of a short section thereof cut out of the main section and connected reversibly thereto by conductors arranged to reverse the direction of the current in such short sections.

Electric Motor Car, W. H. Patton, 475,702. Filed Sept. 7, 1891.

An electric car carrying a generator operated by a gas engine.

Telegraphs and Apparatus :—

Telegraphic Relay, C. Cuttriss, 475,441. Filed Dec. 1, 1891.

Employs a combination with a movable coil, of a divided local circuit, a distensible carbon spiral in each branch of the latter connected with a movable coil on opposite sides of the circuits and a receiving instrument in a bridge between the divisions of the local circuit. See THE ELECTRICAL ENGINEER, May 25.

Electrical Transmitting System, F. E. Now, 475,468. Filed Dec. 4, 1891.

Has for its object to create greater efficiency in the manipulation by a single operator of a number of separate telegraph circuits.

Telephones :—

Extension Transmitter for Telephones, V. A. Cook, 475,300. Filed Jan. 8 1892.

College Notes.

UNIVERSITY OF ILLINOIS.

ON May 19, an audience of two hundred and fifty listened to a lecture on the "Electric Transmission of Power." The speaker, Mr. George Cutter called special attention to the new phases of this subject which have followed the developments in alternating current working. Mr. Cutter had brought with him a collection of apparatus with which he repeated the induction experiments devised by Prof. Elihu Thomson, and in the course of his talk he showed their bearing on transmission problems of the future. The multiphase plant at Frankfort also came in for its share of attention, and the hearers were impressed with the grand outlook in this field.

WASHINGTON UNIVERSITY.

THE course in electrical engineering at Washington University, St. Louis, Mo., commences with the Junior year and extends through the Senior and one year of post graduate work. Even more than the usual amount of mechanical engineering is included in the course, and certain vacation work is also required. The electrical laboratory is well equipped and conveniently wired for experiments and tests.

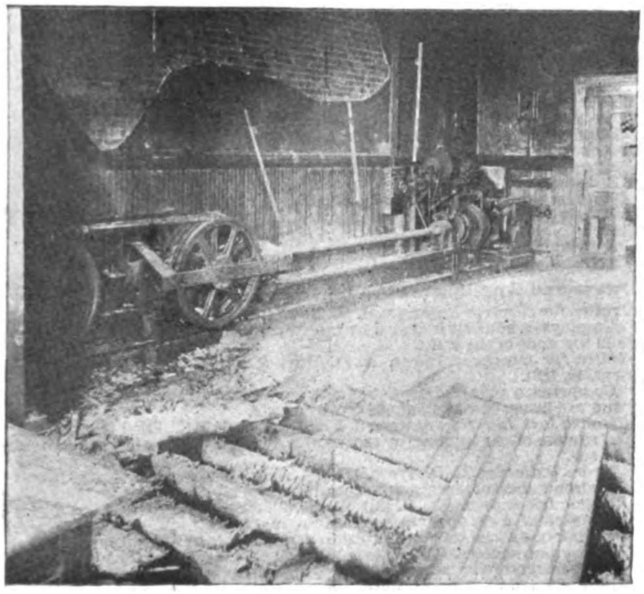
TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

Better is a large advertising account and much business, than false economy and poverty therewith.

THE SPRAGUE ELEVATOR AS A PHŒNIX.

A BRIEF note in our last issue called attention to the fact that a recent fire in the Cassidy Building, in this city, had burned through the fourth floor where the elevator is situated, and had created general havoc before it was got under control. The accompanying engraving—the reproduction of a photograph taken immediately after the fire—shows how intense the heat must have been; in fact, the elevator at first sight appeared to be completely disabled.



SPRAGUE ELEVATOR AFTER THE FIRE.

The insulation had melted from the wires, switches had burned off, the fuses were gone, the controlling cylinder was split, the regulating gear was stiff and somewhat distorted, and the whole machine blackened and clogged with mortar. Part of the machinery had been flooded. It was twelve o'clock before anything could be done towards removing debris, and at seven o'clock at night the elevator was in operation. It altogether seemed a remarkable test of reliability of electrical apparatus when well constructed and properly taken care of.

ENTERPRISE ELECTRIC CO.

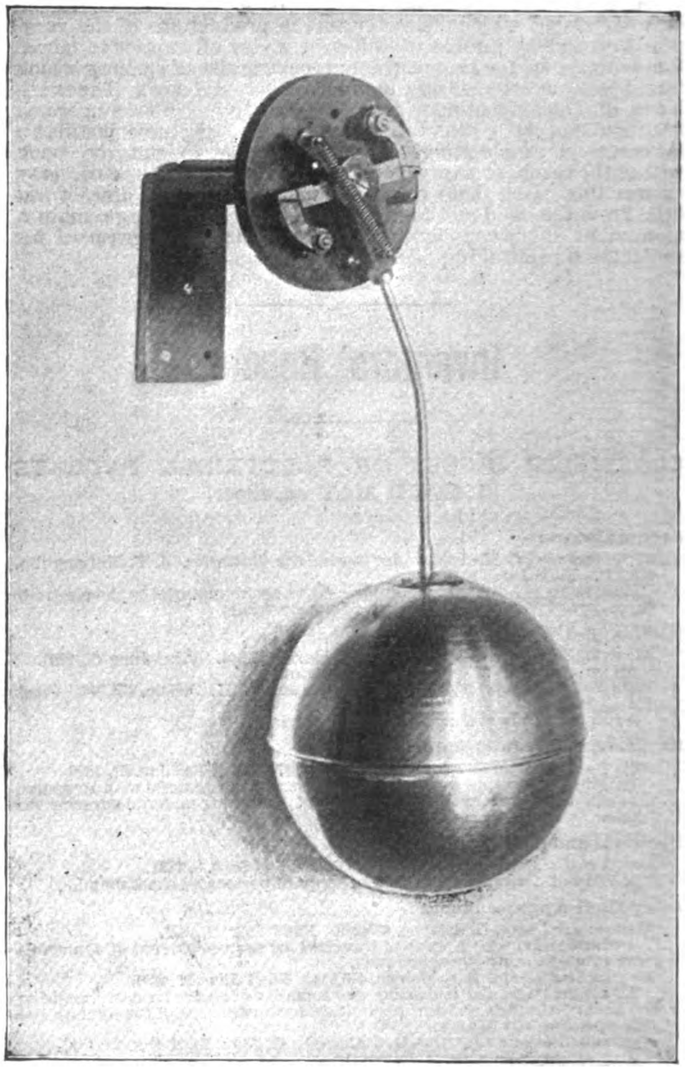
THE above-named company who are manufacturer's agents, mill representatives and wholesale distributors of electrical supplies of every description, have now got their handsome store in the Manhattan Building, 318-315 Dearborn street, Chicago, in order and are prepared to handle a large business in the most expeditious and efficient manner. They are agents for Day's Kerite wire, the fine quality of whose insulation is so well known and which recommends it to users of rubber-covered wire. They are also agents for the Western Electric Co.'s weatherproof line wire which is held in high appreciation by those who have used it, and also their electric light and house goods supplies, which are noted for their quality. In addition to these goods they carry a full line of Paiste switches, Bryant sockets, together with their porcelain goods and a full line of other high grade goods, among which are poles, cross-arms, brackets, oak pins, porcelain and glass insulators, porcelain goods, main line switches, underwriter's wire, and in fact all kinds of material for both inside and outside construction. They have made especial arrangements for making shipments with care and greatest promptness. Attention is called to their announcement in our advertising pages this week, and they will be pleased to receive correspondence from all interested in the purchase of supplies for telegraph, telephone, electric light or electric railway construction.

EDISON SWITCH FOR ELECTRIC PUMPS.

THE EDISON GENERAL ELECTRIC Co. has just designed and put on the market an automatic switch for use with electrically operated pumps employed in filling water tanks.

This is a simple single-pole switch with ebonite base, mounted upon an angle-piece and operated by a ball float. As the water rises in the tank, the ball float rises with it until it reaches a point where the switch is opened by the operation of a spring. The motor consequently stops and no more water is pumped into the tank. As the water is drawn off, the ball falls with the water level, the switch is closed, the pump starts and continues working until the tank is again filled to the desired point. The ball and other parts in contact with the water are insulated from the switch connections and line terminals, so that no part of the circuit can be grounded through the tank. The switch may be screwed to a wall or partition by the side of the tank, or, if convenient, may be placed within and screwed directly to one side of the tank.

The particular switch shown in the illustration is fitted with an arm 7 inches long, and a ball 7¼ inches in diameter, and will operate with a variation of 6 inches in the water level. It requires a space of 11¼ x 18½ x 20 inches, and can be used in any ordinary tank capable of holding more than thirty gallons.



EDISON AUTOMATIC PUMP SWITCH.

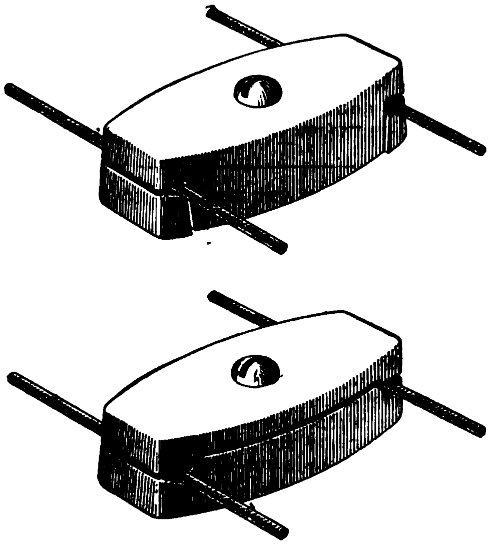
Switches of this type can be used in connection with motors up to 2 K. W. capacity, and can be arranged to operate upon any reasonable change in water level.

DETROIT ELECTRICAL WORKS.

THE above concern, of Detroit, Mich., has reduced its capital stock from $1,000,000 to $750,000. The latter amount has all been paid in.

THE SECURITY CLEAT.

The accompanying illustration shows a front and back view of the new "Security" cleat manufactured by the Security Insulator Co., of 136 Liberty street. The cleat is entirely novel in design, and is claimed to possess advantages over the old styles which will place it in the lead at once. It is made especially for incandescent wiring and, like the "Security" insulator, will hold a wire of any of the usual sizes. The construction of the cleat makes it very strong, and but one screw is needed. No kink whatever is made in the wire, and the insulation is not harmed in the least. It is made of the best vitrified porcelain, glazed or unglazed, and will, doubtless, prove a great convenience as an economizer of time and labor.



Security Cleat.

THE AMERICAN FEED-WATER HEATER.

The accompanying illustrations, Figs. 1 and 2, show the new American feed-water heater, the result of long practical experience in heater-building. It possesses many valuable features, and not a few novel ideas, which are claimed to give it some advantages over other styles. The coils are made of seamless copper tubing and are brazed to the gun metal fittings, thus eliminating, in a large measure, all liability to leak from bad joints. These fittings necessarily pass through the shell, and are threaded for the reception of the feed pipes, so that there are no joints inside the shell. The circular coils are perfectly smooth, have no internal obstruction and, consequently, very little internal friction. In designing these heaters, the area of the shell has been made considerably larger than the area of the exhaust pipe, so that it is not necessary to pass all the exhaust steam through the heater, though sufficient steam will always pass through on account of the vacuum created to raise the feed-water to 200° Fahrenheit. These heaters are well adapted to use with compound engines, increasing the vacuum and delivering the feed-water heated to the maximum degree. Fig. 2 represents a form of heater which is also designed for use as a purifier. It has a large water space unobstructed by tubes, and the conical shape of the bottom gives the mud or sediment a good opportunity to be effectually blown out. The top chamber can be readily taken off, being in no way attached to the steam or feed pipes, and the interior can be easily cleaned out. The coil can also be readily removed, and if coated with lime or other incrustation, easily cleaned and replaced at slight expense. From the peculiar arrangement of its connections, it can be at once cut off from the exhaust steam, or a limited amount of steam can be passed through it when desired, so that any temperature of feed-water can be procured. The coils are made of seamless copper, and the shell, as in the other heater, of cast iron or boiler steel.

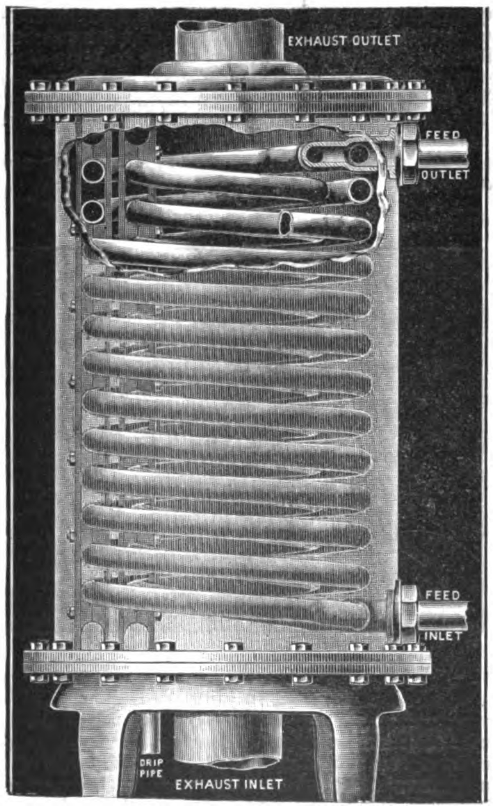


Fig. 1.—American Feed-Water Heater.

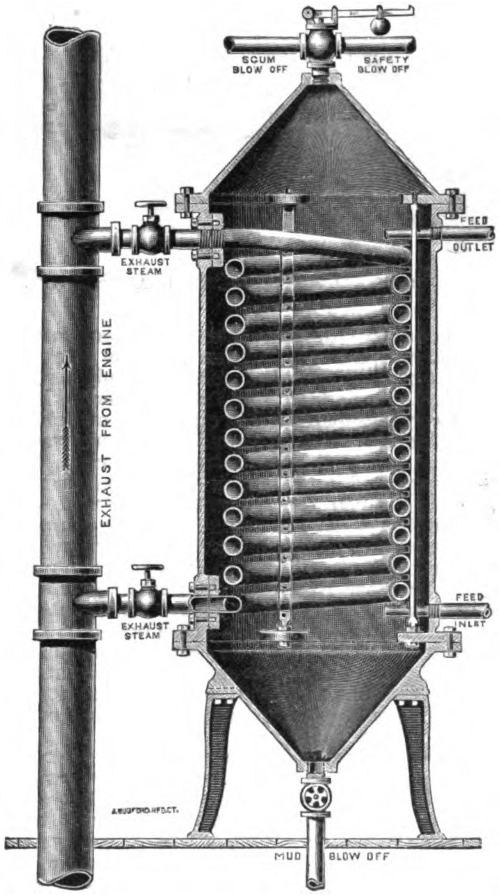


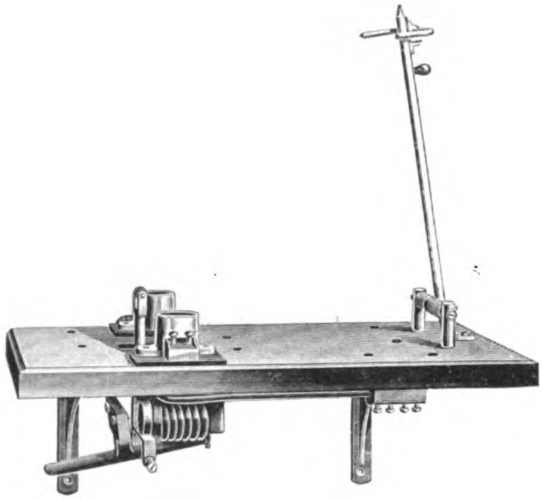
Fig. 2.—American Feed-Water Heater and Purifier.

These heaters are manufactured by the Whitlock Coil Pipe Company, of Elmwood, Conn., who have a New York office in the Mail and Express Building, 203 Broadway, with Mr. John J. Finnell manager. The Jarvis Engineering Company, of Boston, are agents for New England, and have already installed several in the Eastern States, where they are giving entire satisfaction.

Mr. P. C. Ackerman, New York agent of the American Electrical Works, has just returned from a trip through the West, and reports a journey both remunerative and eventful. Mr. Ackerman chanced to be in the locality recently visited by the disastrous floods and had some thrilling experiences. In one instance a train upon which he was a passenger passed through a flooded district where the water actually reached the platform of the cars. An excellent trade and similar prospects are reported, the flood of orders being as high as the top floor of the factory.

THE STANDARD AUTOMATIC OVERLOAD SWITCH.

The Standard automatic overload switch shown in the illustration is designed to open quickly and positively and make a wide break so that a current of high potential can be broken in such a manner as to make it impossible to hold an arc. The length of the arm is about ten inches, while the switch opening is over one foot in length. The arm being thrown up by a strong spring, the break is made so quickly that the arc is broken with certainty.



Standard Automatic Overload Switch.

In order to compare the time taken to open this switch with that required to open a circuit by fuses, a fuse block was put in circuit with one of these switches wound and adjusted to open at one hundred amperes, and different fuses attached. It was found that with a twenty-ampere fuse in circuit the switch was invariably opened so quickly when one hundred amperes was thrown on that the fuse had scarcely sufficient time to warm. When a ten-ampere fuse was placed in the circuit both switch and fuse opened at the same time when the current was turned on. Clearly stated, this switch will open as quickly as a ten-ampere fuse will melt on a one hundred-ampere current. Similar fuses were previously tested and were found to open on currents indicated. The switch is so constructed that mechanical contacts are avoided by the use of mercury cups which insure good contact with perfect freedom of motion. The latch which holds the arm in place is thrown off by the armature of an electromagnet not connected to the latch, and perfectly free to move. The armature is heavy and has quite a distance to travel, so that when it reaches its magnet a heavy blow is given to the latch insuring certain liberation of the switch arm.

These switches are claimed to open within one per cent. of the current to which they are adjusted, whether the current is raised quickly or slowly, and to do their work so quickly that even on a short circuit the load cannot become heavy enough to throw off belts or damage machinery. They are made by the Electro-Dynamic Co., of Philadelphia, who wire them for any current from an arc-light circuit to the heaviest power generator.

AN ILLUMINATING ELECTRIC "SPELLER."

At the recent graduating exercises of the Columbia University Law Class, '92, a very pretty and novel effect was obtained by the aid of what has been termed the electric "speller." This is nothing more or less than a machine which spells words, and even can be made to construct entire sentences. It consists of any desired number of boxes, ranged side by side, and made light-tight, except in front, where they are covered with letter transparencies cut from ordinary cardboard, and having different colored tissue paper pasted over them to give various colors, if desired. In each box is a 16 c. p. lamp. The "speller," which is driven by a C. & C. ⅛ h. p. motor, makes about eight revolutions a minute. It is a cylinder about 14 inches in diameter, around which are placed any desired number of brass strips. The first strip goes completely around, each of the others being two inches shorter than the next one adjoining. From one end of the cylinder to the other, and connecting with the strip that goes entirely around, is another strip to which all the others are connected. Independent brushes carry the current to each strip.

During the graduating exercises above referred to, which were held in the National Theatre, in Washington, D. C., the lamp-boxes were arranged in the shape of an arch suspended above the stage. First flashed out the letter C in orange; next the letter O in blue (these being the colors of the University), until the entire sentence, "Columbia University Law Class '92" was presented in bright colors. After being lit for about fifteen seconds all the letters simultaneously went out, only to be repeated again at the will of the operator. The "speller" can be made to do its work backward or forward by a reversing switch. By the addition of smilax, vines and flowers, with a sprinkling of electric lights artistically arranged, the effect can be made very beautiful.

This machine was designed and built by the Washington Construction Co. for decorative use in the many entertainments that Washington is noted for. We are indebted to Mr. Messner of this firm for a description of this interesting device.

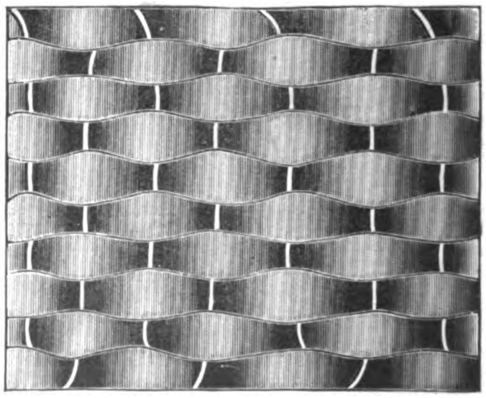
A SHORT RAILWAY PLANT FOR GRAND RAPIDS, MICH.

It is safe to say Mr. James R. Chapman, general manager of the Consolidated Street Railway Co., Grand Rapids, Mich., is one of the best satisfied men operating an electric road. Mr. Chapman has from the first been an enthusiastic believer in a "gearless" street car motor. He placed a large order for these motors with the Short Electric Railway Company, of Cleveland, Ohio, several months ago, and on Sunday, May 22d, the first gearless car was run over his lines. Two trips were made by a large party; one in the morning taking that portion of Grand Rapid lines having grades of from three to five per cent. Later in the day the car was run over the steepest and most difficult sections of track in the system, where it was demonstrated to the satisfaction of every one that the "Gearless" is a first-rate hill-climber. The car ascended one 9½ per cent. grade at a speed of nine miles an hour without the least difficulty. This run was made several times in succession; the car being stopped and started in the middle of the grade with as much ease as on level track. The speed attained on the level was surprising to those accustomed only to cable cars and to the rates attained with the average geared electric motor.

The Short Company manufacture two types of gearless motors; one for high speed on level track, the other for slower speed on grades. The Grand Rapids motors will be of the latter type, owing to the stiff grades on the road, but will make twenty-five miles per hour easily on the level.

THE BRIGGER PATENT WOVE LEATHER BELTING.

The Brigger Belting Company, of Akron, Ohio, are placing on the market a belt entirely different from any other at present made and one that is said to be giving the best of satisfaction. Those acquainted with the manufacture of leather belts are well aware that certain portions of a hide will stretch badly. The Brigger Belting Company, however, claim to have obviated this trouble by a process similar to the ordinary weaving of a piece of cloth. The finished product is shown in the accompanying illustration. Strips of leather cut to a certain width and submitted to a special stretching process are placed on a loom and form the warp, the woof consisting of very strong twine treated chemically. Any width and any length is thus possible. After the belt is woven exactly to the width required, it is taken from the loom, placed on a single facing of leather of the same width and fixed there by a cement, which is also a production of this company, at a pressure of about 15,000 pounds to the square inch.



Brigger Patent Wove Leather Belting.

The Brigger Belting Company though not old, have succeeded in placing a large number of belts in different parts of the country and are in receipt of a great many excellent testimonials. The works are situated in the lively manufacturing town of Akron, Ohio, where the company have large landed interests.

THE ELECTRIC LAUNCH "ELECTRA."

AMONG those who have had an abiding faith in the success of electric launches is Mr. Fred. Reckenzaun, who, in an article published in the ENGINEER some time since, showed that a profitable business awaited those who should undertake the systematic exploiting of this field. Mr. Reckenzaun's figures were based on the results of actual experience, and many of our readers will recall the "Magnet" which was built and operated by Mr. Reckenzaun in New York Harbor and adjacent waters. This little vessel has since been sold to the Pacific Coast, where, after several years of duty, it is still in excellent condition.

More recently the subject of providing electric launches has been taken up by the Electric Launch & Navigation Co., of this city, of which Gen. C. H. Barney is the general manager and Mr. Fred. Reckenzaun, the electrician This company has just finished the construction of an electric launch called the "Electra," which is now being run on the Passaic River at Newark, N. J., and at the invitation of the company, a party of gentlemen representing the electrical press last week enjoyed the privilege of a sail up the Passaic.

The "Electra" is 34 feet long, 6 feet beam and draws 28 inches of water, and is able to accommodate comfortably from 15 to 20 passengers. She is equipped with a 4 h. p. series wound Reckenzaun motor, having a Gramme ring armature, and the fields of which are entirely of wrought iron, being built up of parallel bars. The armature is directly connected to the screw shaft made of Tobin bronze; the thrust is taken up by a ball bearing running in oil. The motor weighs 420 pounds.

The motive power consists of 78 cells arranged in two sets and having a capacity of 125 ampere-hours; each cell weighs 38 pounds. The controlling switch which was designed by Mr. Reckenzun is mounted on a shaft concentric with but independent of the steering wheel, so that the helmsman has perfect control over the vessel with the least possible effort.

With the motor running at its normal rate of 650 revolutions per minute, a speed of about seven miles an hour is obtained which can be maintained for 10 hours, thus giving the boat a traveling distance of 70 miles without recharging the batteries. Four different speeds are obtainable, viz., 3, 7, 9 and 11 miles per hour.

It is interesting to note that the storage cells are operated with gelatinous electrolyte which Mr. Reckenzaun has found to be almost indispensable in electric launch work, as it obviates completely all splashing and spilling of the solution as generally employed, and leaves the vessel without a trace of the odor of acid.

The behavior of the "Electra" is admirable in every way; the vibration due to the screw is almost inperceptible and there is an entire absence of those vibrating shocks inevitable with even the smoothest running reciprocating engine.

Negotiations are now in progress by the Electric Launch & Navigation Co., to introduce their boats on the lagoon and lakes at the Chicago World's Fair, and it is to be hoped that they may prove successful.

ROPE DRIVE TRANSMISSION.

THE Hotel New Netherlands at the corner of Fifth avenue and 59th street will contain, when completed, one of the most powerful rope drives for electric light and power purposes in the country. There will be one 200 and one 300 h. p. drive from Armington & Sims engines to jack-shafts, one of 120 h. p. from engine to dynamo, and four of 120 h. p. from jack-shafts to dynamos. The rope used from engines to jack-shafts is that known as Lambeth cotton, made in Manchester, England, and especially imported for this installation, while raw-hide rope will be used on the dynamo drives. The sheaves are of the built-up pattern, capable of having extra grooves added at any time.

The Link-Belt Engineering Company of Nicetown, Philadelphia, and 49 Dey street, this city, to whom the contract has been awarded, have *carte blanche*, and will make the plant a model one in every respect. We may add that, in conformity with the rule of the hotel, the sheaves, etc., will rejoice in a costume of "baby" blue with gold stripes.

THE RAILWAY EQUIPMENT CO.

THE RAILWAY EQUIPMENT COMPANY, Chicago, reports business as rushing in all departments. They have added largely to the established business of the Electric Merchandise Company, whose business they purchased some few weeks since. Owing to the fact of the standard appliances of this company having such an established reputation, a very large number of late contracts for equipment have been made with the understanding that such appliances will be used.

The company reports a largely increased business over the last season, but having increased its manufacturing facilities, it is able to guarantee immediate shipments. The managers of the company having devoted their entire time and attention to "electric railway supplies only" for several years, are prepared to furnish reliable and complete information to parties about to equip electric street roads. Such inquiries are given the most careful attention, are answered fully and without charge.

MICA ASBETITE.

THE ELECTRIC APPLIANCE COMPANY report having closed arrangements with the Mica Asbetite Insulating Company to represent them in the Western market and carry a large and complete stock of their goods in Chicago. Mica Asbetite is possibly the latest insulating compound in the market for electric railway use, although not new, as it has been in use for some considerable time on some of the largest lines in this country, and the wonderful results that have been obtained has led the Asbetite company to decide to take an active part in electric railway work and push their goods to their proper place in the front rank. The Mica Asbetite compound is unaffected by heat, in fact the appliances are subjected to a heat of over 800 degrees in the process of manufacture. The compound resists water perfectly and the bells can be soaked in water or even acid for any length of time without affecting the compound. The Electric Appliance Company claim to have the coming insulation for railway work, and an examination of the material seems to substantiate their claim.

POWERFUL TURBINES FOR NIAGARA.

THE immense new pulp and paper plant of the Cliff Paper Co., at Niagara Falls is to be supplied with late new designs of the horizontal shaft double-discharge James Leffel wheels, built by James Leffel & Co., Springfield, Ohio. The contract for this work was signed, after the Cliff Co. had made a full and careful investigation, of the merits of various wheels presented during the past year for their consideration. Each of these turbines is to be 1,100 h. p. capacity; and built essentially upon the plan of their style No. 23, illustrated in the pamphlet of James Leffel & Co. These wheels will connect directly to the pulp grinder shafts at each end of the wheel shafts, without belts or gearing.

This water-wheel company has celebrated its thirtieth year of continuous business in this line of work. They have added many improvements, to their James Leffel wheel in the past two years; and have designed a large number of new styles, incorporating in them the best ideas of their large experience. The manufacturing plant of this company, has also been recently greatly extended; and various pieces of new, improved, and heavy machinery added; all adapted to the heavy water-wheel work they are now manufacturing. They shipped some time since one James Leffel wheel and casing weighing forty-five tons; also filled one order for nineteen large wheels for one pulp and paper company.

QUICK RACE REPORTING IN ENGLAND.

WITH regard to the very quick reporting of the Oxford and Cambridge boat race on the Thames, recently mentioned in our columns, it should be stated that this feat was due to the enterprise of the Exchange Telegraph Co., Ltd., of London, from whose boat a cable was paid out so that no time was lost in sending news of each stage of the great contest.

AN EXHAUST STEAM PLANT FOR CEDAR RAPIDS, IA.

THE CEDAR RAPIDS, IA., ELECTRIC LIGHT AND POWER COMPANY has contracted with the American District Steam Company, of Lockport, N. Y., for the construction of about one mile of 12, 10, 8 and 6-inch steam mains, to be used for the distribution of exhaust steam for heating dwellings, offices, stores and public buildings in that city.

THE PREMIER ELECTRIC MOTOR.

THE PREMIER ELECTRIC Co., of 17 and 19 Whipple street, Brooklyn, have sent us the following communication:

BROOKLYN, N. Y., May 25, 1892.

WE desire to state publicly "through the columns of THE ELECTRICAL ENGINEER," that we have the sole right to manufacture electric motors, under Letters Patent 321,049 June 30, 1885, and that Mr. Wm. S. Pendleton, of the Premier Electric Co., is the sole owner of the above patent, which fully covers the use in a motor, of an armature having three poles as connected to make a self-starting motor. We are prepared to fill the wants of the trade and manufacturers; and the trade at large are hereby warned against the manufacture or sale of motors, having this armature "other than our manufacture," as all infringers will be prosecuted.

Very respectfully yours,
THE PREMIER ELECTRIC CO.,
By ELMER F. KELLY.

THE PURITY OIL FILTER MANUFACTURING CO.

THE following is an abstract from a letter recently received by the above company, that speaks for itself:

We pour into the No. 4 Ideal Steam Oil Refiner every 24 hours about 10 gals, of dirty oil and draw out an equal amount of purified oil which seems to be excellent for all uses about the Rod Mill engine except for cylinders, and moreover, we find we can substitute the purified oil for the more expensive lard oil which we have hitherto deemed it necessary to use on the crank pin and crosshead slides.

NEW CASTLE (PA.) WIRE NAIL CO.
Edward King, vice-president.

MR. F. S. TERRY, general manager of the Electrical Supply Co., of Chicago, has returned from a business trip East.

NEW YORK NOTES.

The Short Electric Railway Company report orders for additional apparatus from the Bloomington City Railway Company, Bloomington, Ill., ten 40 h. p. single-reduction equipments and one 100 h. p. generator; South Covington and Cincinnati Street Railway Company, four 40 h. p. single-reduction equipments; Schuylkill Electric Railway Company, Pottsville, Pa , four 50 h. p. single-reduction equipments; West End Street Railway Company, Rockford, Ill., six 20 h. p. gearless equipments; Georgetown and Tenallytown Railway Company, Washington, D. C., two 40 h. p. single reduction equipments; Wilkesbarre and Wyoming Valley Traction Company, Wilkesbarre, Pa., three 60 h. p. single-reduction equipments, one 200 h. p. generator; and the Braddock Electric Railway Company, Braddock, Pa., one 40 h. p. single-reduction equipment. They have also closed contracts recently with the Baltimore Traction Company, Baltimore, Md., and the Janesville Street Railway Company, Janesville, Wis.

The Jersey City and Bergen Railroad Company, of which Mr. C. B. Thurston is president. has just closed an important contract with the Ball and Wood Co., of New York, for three of their improved cross-compound engines of 300 h. p. each. The engineers of the Pennsylvania Railroad have carefully investigated eight leading makes of engines, which were in competition for this contract. The intention of the company is to make the plant which will operate its lines a model one not only in respect to the latest and most approved type of engines but in its other equipment and arrangement.

Short Electric Railway Co.—The Philadelphia agency has been consolidated with the New York and Mr. Wm. Hazelton, 3d, has removed to Cleveland, Ohio. Messrs. S. L. Nicholson and Frank R. Ford will be located at the New York office as agents. A great deal of attention has been given to the work of the Short Co. by the New York papers during the past week, owing to the announcement that Prof. Short is ready to grapple with the problem of running the Third Avenue Elevated Road by electricity.

The Crescent Insulated Wire and Cable Co., of Trenton, N. J., suffered from a fire in its factory, last month. The roof and fourth floor of the structure were completely destroyed. The company write us: "The loss from our enforced stoppage, though for a brief period only, will be considerable, as we have been for the past three months taxed to our utmost capacity and far behind our orders. We hope to be able to resume running full in about two weeks."

A Correction.—The E. S. Greeley and Co., write us that Mr. Ralph A. Schoenberg, who was recently reported to be representing that concern, has no connection with it whatsoever, and that his recent business trip was made entirely in his own behalf.

Mr. Eugene Phillips, president of the American Electrical Works, was a New York visitor last week and called at the new headquarters of The Electrical Engineer.

NEW ENGLAND NOTES.

The Redding Electric Company, of Boston, have recently been doing an excellent business in watch-clocks, and last week received orders for no fewer than twelve complete clock equipments. As is well known, their clock is the only one which gives a plain printed record, a fact which seems to be telling largely in their favor as they become better known. These twelve clocks ordered are going to the following cities: Denver, Col., Provo City, Utah. Huntington, W. Va., New York City, Pittsburgh, Pa., Syracuse, N. Y., Evansville, Ind., Lexington, Ky., Jackson, Mich., and three to Mexico.

The Consolidated Electric Manufacturing Company, of Boston, are in receipt of an important order for Heymann arc lamps from Central America, which they received direct from an illustrated article in a recent issue of The Electrical Engineer. The purchaser wrote saying, "The article in The Electrical Engineer caught us dead." The Consolidated Company are extremely busy in this line of work, and judging by the number of orders which they have received for the "Heymann," it seems to have taken the public and to be giving satisfaction.

The Westinghouse Electric Company have sold, through Mr. R. S. Brown, their New England agent of the railway department four car equipments to the Natick and Cochituate Street Railway Company of Natick, Mass. This road has previously been operated by horses, but will now be changed over into an electric line, and will be extended to Saxonville, a distance of about 10 miles. There will be one motor on each car of 25 h. p.

The Thomson-Houston International Electric Company, whose headquarters have hitherto been at 620 Atlantic avenue, Boston, will remove their offices about July 1st to larger and more commodious offices on the eighth floor of the Edison Building, New York City.

Mr. Francis R. Hart, of the Massachusetts Electrical Engineering Company, of Boston, has just returned from a three months' business trip in Jamaica and the Republic of Colombia, and has a few real Mexican cigars to regale his friends with.

Mr. James H. Mason, general manager of the Simplex Electrical Company, of Boston, has just returned from a four weeks' trip in the West, and is well pleased to find that Simplex still finds hosts of admirers in that section. Some of the largest buildings in the West are wired with Simplex, and the good record which they have given is inducing many more architects to adopt it for a thoroughly good safe insulation.

The Pettingell-Andrews Company, of Boston, have just added another useful specialty to their long line of goods in the shape of the P. A. blow lamp. This lamp is used for soldering line work both inside and outside of doors, and is also largely used by painters for scorching off old paint. It is quite different in design from all other blow lamps in the market, and should be of interest to all wiremen.

Albert & J. M. Anderson, of Boston, are in receipt of their first order from Mr. Blackwell, their London agent, for the line equipment of an electric street railway, and are congratulating themselves that "Ætna" seems to have caught the British public. They have just appointed Messrs. J. C. White & Co, of St. Louis, Mo., as their agents for line material in that territory.

The Eastern Electric Light and Storage Battery Company, of Lowell, Mass., are furnishing a tested fuse wire in all size from 8 to 100 amperes, in one-pound spools. This wire is made from a special alloy, and each size is guaranteed to carry the current marked on the spool, and bears a certificate of the company to that effect.

WESTERN NOTES.

Mr. Thos. G. Grier, Western manager for the Bryant Electric Co. has removed from 427 the Rookery Building to 1522 Monadnock Building, and is now settled in his new office. Mr. Grier for the past year has been managing the H. T. Paiste business in the West. The Bryant Electric Co. have purchased the patents of the Paiste single-pole switch. In addition to the other specialties manufactured by the Bryant Electric Co., Mr. Grier will handle the Paiste single-pole switch. The Bryant Electric Co. have also purchased the absolute control of the K. W. rosettes and cut-outs.

Mr. W. L. Silvey, of the Dayton Manufacturing Co., Dayton, Ohio, recently shipped two carloads of his No. 30 storage battery to the C. & O. railroad for train lighting work, and he has also unfilled orders for four carloads more. He is making these batteries in three different sizes and among other uses to which they are being put is the lighting of horse street railway cars, which is somewhat of a new departure. He has recently furnished a set to H. Ward Leonard, of New York, to be used for testing purposes.

Mr. Gilbert M. Smith, manufacturers' agent, 925–927 Unity Building, 79 Dearborn street, Chicago, announces that he will represent directly at that place a few leading makers of brass and copper bare and insulated wire, hardware specialties, etc. Mr. Smith has had eleven years' experience with the Ansonia Brass & Copper Co. and for the past four years acted as manager of their Chicago branch.

Mr. H. G. Osburn, who has been connected for some time with the Edison General Electric Co., has resigned his position and associated himself with the Bain Electric Mfg. Co., to look after the selling part of their business. Mr. Osburn, with his pushing qualities and apparatus so well known as the Bain, will undoubtedly largely increase that business.

Mr. John R. Markle, financial and fuel gas, steam and electrical expert, of Detroit, Mich., was a Chicago visitor last week and called at the office of The Electrical Engineer. The Western office of The Electrical Engineer was also favored by a call from Mr. E. H. Cutler, manager of the Elektron Mfg. Co., Springfield, Mass.

Mr. J. H. Cooke, manager of the Chicago office of the Buckeye Electric Co., reports that since May 1, their orders for Buckeye incandescents have far exceeded their most sanguine expectations and that their coiled filament lamp is in great demand.

Mr. W. S. Mullen, of the Union Electric Co., 45 Broadway, New York, manufacturers of storage batteries, spent a few days in Chicago last week.

Mr. R. Humffreys-Roberts, secretary and manager of the Fontaine Crossing Co., Detroit, Mich., spent a few days in Chicago last week.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

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THEORETICAL ELEMENTS OF ELECTRO-DYNAMIC MACHINERY—VI.[1]

BY

A. E. Kennelly

RELUCTANCE.

IN order to determine the flux in a magnetic circuit, we might, in accordance with results thus far obtained, proceed to find the distribution of potentials (assuming that such existed), from this, the gradient B, and then calculate the surface integral of B over an area drawn once across the circuit. But there is another method more direct and comprehensive, which will enable the flux to be found, ideally, at least, if not practicably, and that is, by determining the total *reluctance* in the circuit. This reluctance, divided into the M. M. F., gives the flux as quotient. Reluctance is thus the analogue in the magnetic circuit, of resistance in the galvanic, with the distinction already referred to in Part I, that while resistance checks the flow of current, it exchanges the electrical into thermal energy, while reluctance acts as a regulator of flux only.

We are now enabled to apply Ohm's law to the magnetic circuit in the form $F = \frac{M}{R}$, where F is the flux, M the M. M. F., and R the reluctance of the circuit.

Simple as is the rule, and easy of recollection by its analogy to the fundamental law of the galvanic circuit, it very frequently fails in practical application, owing to the difficulty in detail with the calculation of reluctances. This is incidental to the fact that there is no known magnetic insulator. Resistances in the galvanic circuit are usually easy to determine numerically, for they commonly belong to wires, which are uniform cylinders or are considered as such. Magnetic paths are, on the contrary, almost always divergent and irregular.

The problem of finding the reluctance of a circuit is generally similar to that of finding the joint resistance of a bundle of metallic wires all connected in parallel, whose lengths are variable, and whose individual cross-sections differ from point to point. Apart from this numerical difficulty, the determinations of reluctance and resistance are essentially alike. A substance would have unit specific resistance or resistivity, when a block of it one centimetre cube, would offer one unit of resistance between two metallic plate electrodes pressed against opposite faces. A M. M. F. of unity, separating two opposed parallel faces one centimetre apart, would establish unit intensity in the intervening space, because the gradient of potential would evidently be one erg on the unit pole per centimetre, for which one C. G. S. line of flux will be accorded to every square centimetre of surface. In other words, unit reluctance is that of one centimetre cube of space in the air-pump vacuum. In reality the difference between the reluctance of space in the exhausted air-pump receiver, and that of wood, copper, flint, and nearly all substances except the magnetic metals, is so small that it may be practically left out of consideration.

As an example of applying the principle of reluctance to magnetic circuits, let us consider a closed circular solenoid of the anchor-ring type, already discussed in Chap. IV. Let the cross-section of the ring have any shape, and an area of a square centimetres. Also suppose the mean radius of the ring to be r centimetres, and r to be so large compared with the ring's thickness that the intensity which we know to be greater at the inner and lesser at the outer circles, may be taken as uniform through the ring without sensible error. The winding is to have N turns, and through these a current of c units is to circulate. Then for each centimetre of magnetic circuit, there will be a square centimetres in parallel, giving a reluctance per centimetre of path $= \frac{1}{a}$, and since the total length of circuit (a circle of radius r) is $2 \pi r$, the total reluctance will be $\frac{2 \pi r}{a}$. The M. M. F. is 4π times the current turns on the ring, or $4 \pi N c$, and the flux $= \frac{4 \pi N c a}{2 \pi r} = \frac{2 N c a}{r}$, the result obtained in Chap. IV.

As an example, let the ring have a mean radius of 50 cms., and a section of 5 square cms. If uniformly wound with 1,200 turns of thin wire carrying a current of two amperes, or 0.2 C. G. S., the M. M. F. will be

$$4 \pi \times \tfrac{2}{10} \times 1{,}200 = 3{,}016;$$

and the reluctance $\frac{2 \pi \times 50}{5} = 6.2832.$

The flux will thus be $\frac{3{,}016}{6.2832} = 480$, and the mean intensity $B = \frac{480}{5} = 96.$

Closely related to the conception of reluctance, is another, often very useful, *permeance.*[2] The two are mutually reciprocal. Reluctance having its galvanic analogy in resistance (ohms), permeance represents conductance (mhos). The flux in a circuit is the M. M. F. multiplied by the permeance, and if we represent the latter by the symbol P,

$$F = \frac{M}{R} = M P; \text{ so that } P = \frac{1}{R}, \text{ or } R = \frac{1}{P}.$$

The permeance of a conducting channel in which the lines of flux are parallel, would be the area of the channel in square centimetres, divided by the length in centimetres; but as such uniform channels are rarely encountered, the permeance has to be found by supposing the actual channels divided into a large number of short columns, comprised between successive equipotential surfaces, determining the permeance of each lamina separately, and afterwards compounding them in series.

As an instance of the application of permeance and its principles, to the determinations of magnetic circuits, we may consider the case of a closed, circular solenoid whose cross-section is too large, relatively to its radii of revolution, for the assumption of a uniform intensity everywhere within. We will suppose that its section is rectangular, as shown in Fig. 14, with sides parallel to the axis of revolution. Let the radii be R and r, and the height h. Also, let the winding layer be so thin that the amount of flux in the substance of the conductor need not be considered. As before, the M. M. F. will be $4\pi Nc$. The mean path of the flux will be greater than $2\pi r$ and less than $2\pi R$; but it will not be the arithmetical mean of these two limits, because the flux is denser at the inner portions of the section. By dividing up the section into a large number of thin rings such as that represented between the radii ρ and $\rho + d\rho$ we may find the permeance of each separately, and then sum them all for the total permeance. The permeance of the thin ring indicated will be its area $h\, d\rho$ divided by its length or $2\pi\rho$, and we have to sum all these terms between the radii r and R; this is given by the integral

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[1] *Copyrighted* 1892, *by A. E. Kennelly.*

[2] Silvanus P. Thompson, "The Electromagnet," page 178.

$$P = \frac{h}{2\pi}\int_r^R \frac{d\rho}{\rho} = \frac{h}{2\pi} \log_e \frac{R}{r}$$

representing the total permeance.

The flux in the solenoid is

$$F = 4\pi Nc\, \frac{h}{2\pi} \log_e \frac{R}{r} = 2\, Nch \log_e \frac{R}{r}$$

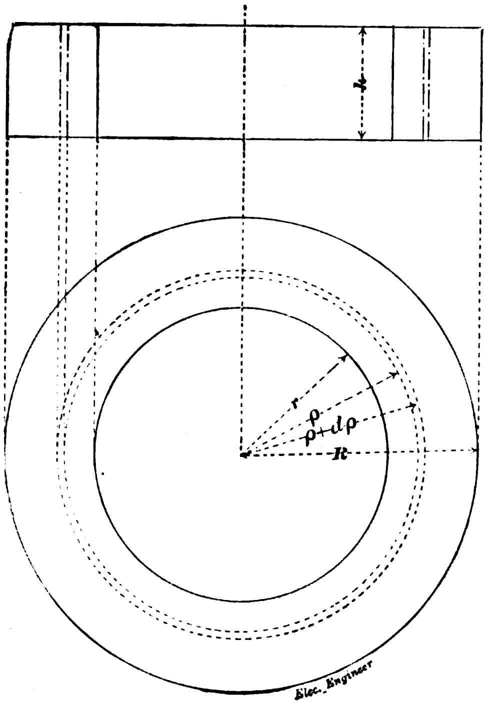

FIG. 14.

This will be the formula to employ for a closed circular solenoid of rectangular section, when the simpler expression already given is not sufficiently accurate for the purpose in view.

As an illustration, let $R = 15$ cms.; $r = 10$; $h = 5$; and $N = 500$, with $c = 1$ ampere or 0.1 unit; $M = 4\pi \times 500 \times 0.1 = 628.3$.

The permeance

$$P = \frac{5}{6.2832} \times \log_e \frac{15}{10} = 0.3227,$$

so that $F = MP = 628.3 \times 0.3227 = 202.8$ with a mean

$$B \text{ of } \frac{202.8}{25} = 8.112.$$

If we had been content to employ the previous formula, with a mean radius r of 12.5, and a cross-sectional area of 25 sq. cms., we should have obtained

$$F = \frac{2 \times 500 \times 0.1 \times 25}{12.5} = 200,$$

and the mean $B = 8.0$; or we would have underestimated the flux by about 1½ per cent.

Although the difficulties that beset the numerical determination of reluctances are generally prohibitive, the ideas it embodies and suggests are often valuable in dealing with magnetic circuits. Thus it is evident that the flux through a single circular turn of wire carrying nc amperes must be greater than that through a long solenoid of the same diameter, having n turns through which a current of c amperes circulates, for although the M. M. F. in each magnetic circuit will be the same, there will be, roughly speaking, an additional reluctance in the solenoid of $\frac{l}{a}$, where l is its axial length and a its cross-sectional area, besides that due to a longer exterior path. For a given number of turns, short coils of large area emit the greatest flux. Practice in the measurement of magnetic circuits trains the eye to form an estimate of the flux that a coil will emit, per ampere of circulating current. The conditions for the maximum total flux are often adverse to the development of a high intensity.

Permeances vary directly, and reluctances inversely, with the linear dimensions of a geometrical system of conductors. Suppose that any arrangement of coils or wires is fixed in space, and that a steady current is flowing through them. If we imagine all the equipotential surfaces properly described, the values of the intensity and of the flux in the circuits or combination of circuits will be definitely determined. Then if the linear dimensions of the whole system be suddenly increased, or diminished, in a given ratio—if its scale of construction be altered—the permeances of each circuit, or corresponding portion of a circuit, will have been altered in the same ratio. If the scale had been increased three times, the relative arrangement of equipotential surfaces will not have been affected by the change, but corresponding distances being everywhere trebled, the gradient of potential will be three times less. The lessened intensity will, however, be carried through areas that will be all correspondingly increased nine times, and the aggregate flux will therefore be three times as great as in the original. Or, from the point of view suggested by the conception of permeance, each elementary path of flux will have been lengthened three times, but enlarged nine times in cross-section, so that its reluctance will be three times less and its permeance three times more.

Consequently, if the flux is once determined for a magnetic circuit, it increases directly with the dimensions or scale. This implies that the diameter of the conductors is altered in the same proportion. With this assumption, the flux in a circuit of a given form, number of turns, and current carried, will be proportional to the length of wire it contains.[3]

A NEW SUBWAY COMMISSION FOR BROOKLYN.

MAYOR BOODY has appointed Prof. George W. Plympton and Frederick R. Lee as the two members of the new Brooklyn Electrical Subway Commission provided for in a bill signed by Governor Flower recently. The measure was drawn by the local electrical companies, and the $3,000 a year to be paid to each commissioner, in addition to the running expenses of the commission, will be raised by these companies. Prof. Plympton was a member of the old Subway Commission, and has charge of the Scientific Department of the Polytechnic Institute. Mr. Lee is a lawyer and has been prominent in all the independent Democratic movements of recent years.

ELECTRIC POWER ON A STEAM ROAD.

ONE of the first experiments in the country in using electricity in place of steam on a standard gauge railroad will be made at Ellwood, Pa. H. W. Hartman is going to introduce it on one of his roads, the Beaver and Ellwood, from Ellwood to Ellwood Junction, a distance of three miles from Pittsburgh, where it connects with the Pennsylvania lines and the new bridge crossing the Beaver River, and connecting with the Lake Erie Railroad. The electric cars will be run over the same road and rails used by the present steam line.

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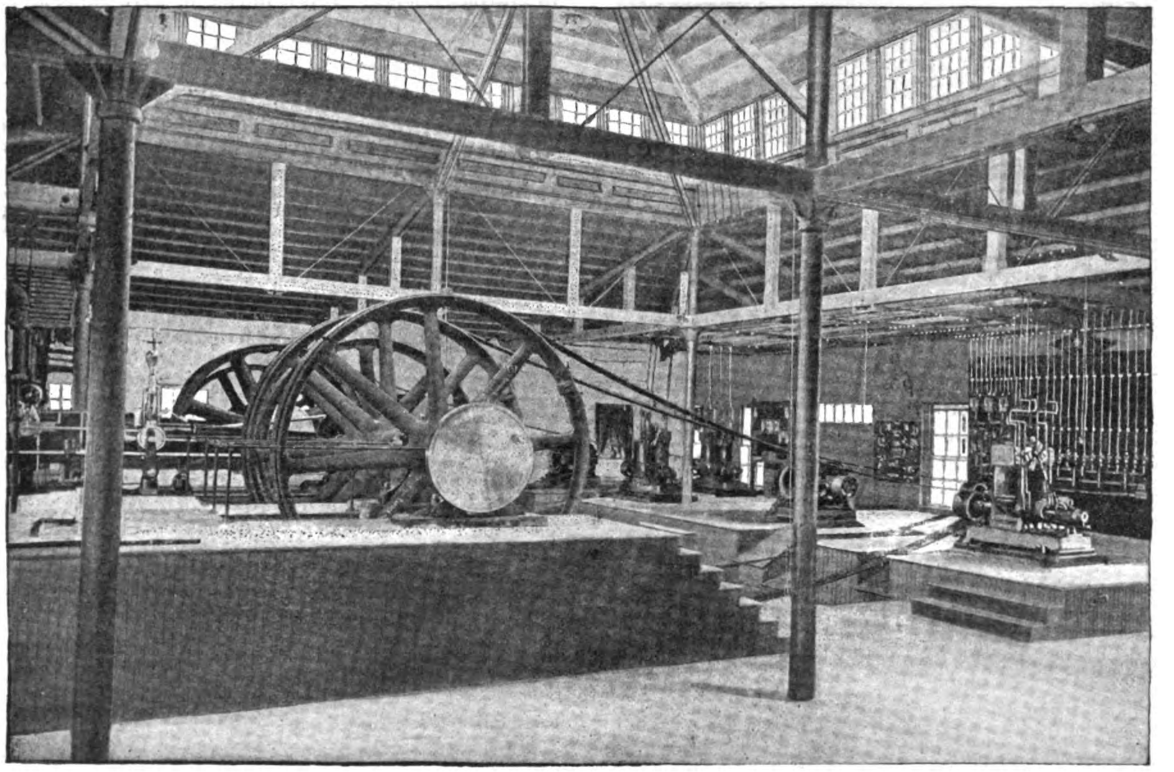
[3] *Vide* a paper by Carl Hering before the Franklin Institute, May, 1892.

THE NEW EDISON PLANT AT NEWPORT NEWS, VA.

AS IN nearly all cities in the Union laying claim to commercial importance, electricity has been called in to play its part at Newport News and a short description of the Edison plant erected there will prove of interest.

Recently a company was formed to light the town on a more comprehensive scale than it had been hitherto. This company, the Peninsula Electric Light Company, began work at once by introducing the Edison three-wire system of distribution for incandescent lighting. The two arc machines forming the plant of the old company were purchased by the new one and set up in the new station, and to the Edison General Electric Company was confided the entire work of installing the new station.



THE NEW EDISON PLANT AT NEWPORT NEWS, VA.

At the outset it was computed that two 45-kilowatt Edison compound-wound dynamos would suffice to meet the demand, but before the work of putting in these was completed, the Peninsula Company found the demand increasing so largely as to necessitate the installation of two additional 45-kilowatt machines. The capacity of its incandescent plant is now, therefore, 180 kilowatts, or about 2,200 lights.

The engines used to drive these dynamos are of the Green automatic type, slow speed engines, belted directly to the dynamos so that there are no countershafts, as shown in the accompanying engraving. The belts from the dynamos run off this slow speed shafting by means of very large pulleys, the diameter of which is about 12 feet. This extreme diameter renders it necessary to have long belt centres, and these vary from 22 to 26 feet. Link belts are used exclusively. The leads from the dynamos are brought overhead to the switchboard, bare copper rod supported on porcelain insulators being used throughout.

As the dynamos are of the compound-wound type there are three wires from each dynamo to the switchboard, and in order that either one of the dynamos may be used on either side of the three-wire system a special switchboard has been devised by the Edison Company and shown in the cut. It is practically a double-throw three-blade switch with a cross-connection between the upper centre and the right-hand lower clip. Connections are made to these switches in such a way that when the handles are all up the dynamos are all connected on the positive side of the system, and when the handles are down, the dynamos are all on the negative side. When two handles are up and two down, two dynamos are on each side of the system. Five feeders run from the switchboard. Each of the outside wires of the feeders is provided with a switch with a safety fuse attachment, the neutral of each feeder having a simple safety catch holder with fuse. On each side of the main switchboard is another smaller one on which are mounted the pressure indicator and galvanometers.

The pole line is about four miles long and there are about 21 miles of wire in the system. The line has a capacity of 1,500 lights burning at one time, and the idea at first was to wire the buildings for about 1,000 lights. Before the installation was complete, however, the demand for lights suddenly increased and the total number of lights connected at the time the station was started was about 2,000 16 c. p. lamps.

The energy displayed in the erection and completion of this plant shows the appreciation by the Peninsula Company of the fact that there existed an urgent demand for electricity in this rapidly growing town, and a desire to satisfy it without delay with as good a plant as could be obtained.

THE LAUNCH "ELECTRA."

In our last issue we gave a brief account of the new electric launch "Electra" and this week we are enabled to present several views of her. The engraving Fig. 1, shows her as she appeared on the Passaic River and Fig. 2 is a view looking towards the bow.

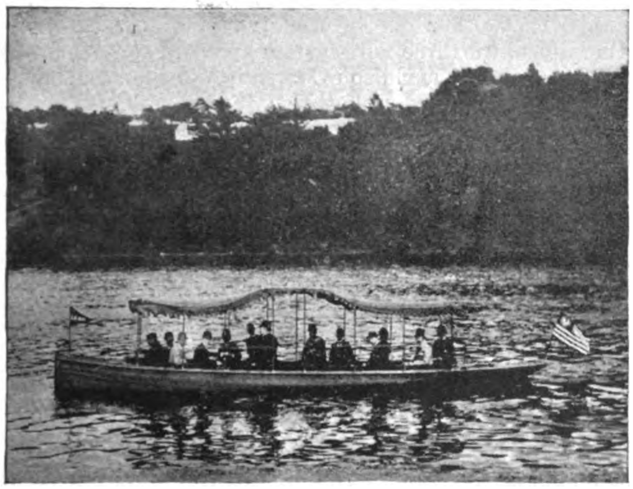
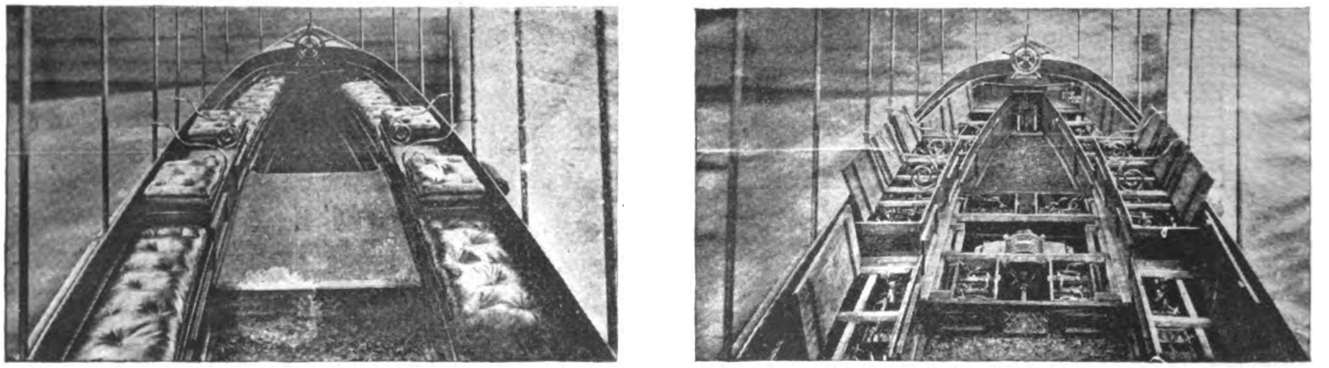


Fig. 1.—The "Electra."

The arrangement of the cells and motor are well shown in Fig. 3 which is taken from the same point of view as Fig. 2. The "Electra" was built by the Electric Launch and Navigation Co., of this city, and is intended as a sample boat for the passenger traffic on the enclosed waters, at the World's Columbian Exposition, Chicago. She is to be submitted for test and approval by the Exposition management, and has already been shipped to Chicago with that end in view. This passenger traffic is expected to require some 50 or more such boats.

The dimensions of the "Electra" are as follows:



Figs. 2 and 3.—View Toward Bow; Showing Arrangement of Batteries and Motor.

Length, over all, 34 feet; length (loaded water line), 31½ feet; beam, 6 feet; maximum draft, 26 inches. She will seat from 25 to 30 passengers. Her motive power consists of 78 storage cells of the Consolidated Electric Storage Co.'s 17 S type, and a 4 h. p. Reckenzaun motor capable of developing as high as 12 h. p. for a stretch. She is fitted with an electrical whistle or trumpet and with electric incandescent lamps for signal lights and illumination.

The Wightman Electric Manufacturing Company, of Scranton, Pa., has its contract for the furnishing of twenty car equipments and a 300 h. p. generator for the Seashore Electric Railway Company, at Asbury Park, N. J., well under way.

ELECTRO-TECHNICAL EDUCATION.[1]

BY PROF. R. B. OWENS.

Until within the past few years the value of the manual element in education has been sadly overlooked in elementary instruction in this country. Special and distinct schools, called variously Manual Training Schools, Schools of Mechanic Art and Developing Schools, have arisen where those elements which underlie all industrial pursuits have been introduced into general elementary education, not because students leaving such schools expect always to enter upon some trade or into some "Trade School," but because such instruction is eminently "desirable for the roundness and unity of general education, and valuable no matter what the future of those so educated may be."[2] The Massachusetts Institute of Technology, the Washington University, St. Louis, and others, have attached to themselves schools of mechanic arts and manual training schools for the reason, I take it, that the elementary public schools do not afford such instruction, and they recognize the great educational value of their training.

In studying the various courses given in the best technical schools in this country and abroad, and the opinions of educators and engineers, I take it that a technical school is primarily a place for the preparation of men who expect to earn their living as engineers. It is not a school of general culture, nor is it a school of abstract science. It is a device to save time, and teaches the applications of pure science to industrial purposes.

A technical school is also, I claim, a post-graduate school in the ordinary sense, and in this respect should rank with schools of law and medicine. If the engineer is a man who uses both the results of science teaching and mechanical skill, he must certainly have great familiarity with both, and the attaining of such familiarity will constitute his undergraduate work. But, after such general knowledge is acquired, no time should be lost in fitting each student to be of the greatest immediate value to those who employ him. Unfortunate as it may be, we must reconcile ourselves to the necessity of becoming specialists. It may be argued that "The more a man knew of all the related branches the better he could perform his special work, but this is only arguing the advantage of omniscience."[3] Time was when all known about electricity would not greatly tax the ordinary intellect, but now each student can only hope to become an expert in one very narrow department, and I believe we must shape the courses, as far as possible, in our electro-technical schools to meet the requirements of the times.

Of course, to employ a number of specialists and to give each student the opportunity to choose the work he is best fitted for will be expensive, but if our country is to keep pace with others in industrial progress she must educate her engineers. When private generosity fails, State aid must be forthcoming or we will have to witness others surpass us in the race for international position. "It is in consequence" of superior industrial and technical education "that Germany is gaining a better industrial position daily."[4] And the same might be said of several other foreign countries, so that on the score of economy no more profitable expenditure of public money is possible than for the support of technical schools. Education is not a money-making business. "No fact is more firmly established all over the world than that higher education can never be made to pay for itself."[5] No considerable income can be anticipated from student fees. Higher education must look for its support to private munificence or public help, and, as suggested to the English Institution of Electrical Engineers by Prof. Ayrton, it would seem to be the duty of such a body as this to influence as far as possible public opinion in favor of advanced electro-technical education.

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[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, June 6, 7 and 8, 1892.

[2] President J. D. Runkle, "Manual Element in Education."

[3] T. M. Drown, *Journal Franklin Institute*.

[4] Prof. R. H. Thurston.

[5] Prof. Rowland.

Having seen the importance of manual training as a factor in elementary education, and knowing its special value to those intending to become either handicraftsmen or engineers, I would recommend that a fair knowledge of forging and foundry work, pattern making, wood and metal turning, and drawing be required of every student for matriculation into any college course. Such an elementary knowledge can readily be acquired by the average student by the age of 16 or 17, along with the elements of English education, such as given in our high schools and academies.

The importance of drawing can hardly be overestimated. It is rightly called "the shorthand language of modern science," and every one can learn to draw with a fair degree of accuracy, although the "negative faculty of drawing in some people is almost miraculous."[6] I do not mean artistic drawing, painting and perspective, but the elements of orthogonal projection can be as easily acquired as the art of writing, and for some purposes it is just as useful. At the age of 16 or 17 a boy having had good advantages should be able to enter any of our best American colleges, and here, if he intends becoming an electrical engineer, I would have him study for three years mathematics, chemistry and physics, with German and French. These apparently few subjects will absorb the greater portion of his energy. Nothing is gained by working at excessive pressure in early life; and as to knowing anything about engineering itself, it would seem best to leave that alone until a thoroughly good scientific education had been first acquired. When electrical engineering is taken up in earnest the student should have such a command of physical and chemical facts and methods, and be such a master of mathematical analysis as to leave him free to discuss engineering problems without the necessity of first acquiring the facts and methods he may wish to make use of.

A good course in modern geometry, differential and integral calculus, say, according to Williamson, and differential equations, say, Forsyth or Craig, would be sufficient to pursue with advantage nearly any course in electrical engineering given in this country at the present time, and when in reading Maxwell it becomes convenient to have quaternions or spherical harmonics, they can be studied in connection with such reading. But to attempt to analyze the action of alternating current apparatus without the use of differential equations, is, to say the least of it, no very easy task. We admit the value of geometrical methods and especially as expressing in convenient form, the result of algebraic analysis. Indeed, in the hands of Mr. Kapp, Mr. Blakesley and a few others, they have been used with excellent analytic effect, but their general weakness as compared with modern methods, is too well known to need comment. As regards the amount of general physics required, I should say the student ought to be familiar with the theory of heat measurements, thermo-dynamics, the principles of fluid motion, the dynamics of a particle, and of solid and rigid bodies, the theory of sound and physical optics, and the facts and principles of magnetic and electric actions. Above all he should be able to apply mathematical reasoning to physical problems and be skilled in the art of experiment.

In ordinary electrical work a knowledge of inorganic chemistry would perhaps suffice, but if one expects to make a specialty of electro-chemistry, then both organic and inorganic chemistry should be required.

Besides mathematics, chemistry and physics, which must be considered as principal subjects of the directly preparatory course, German and French should be acquired, as so large a part of our best electrical literature is in these languages. Sanscrit and psychology might be classed as electives, as affording variety.

Assuming that a thorough working knowledge of mathematics, physics and chemistry is possessed by the student, then I believe he should spend three years in studying the applications of his acquired facts and principles before attempting to practice his profession.

We must, I think, recognize three classes of electrical engineers in this country at this time: First, the installing engineer, who superintends the equipment of central or isolated electric light or power plants, electric railways, mining plants, etc., and runs them when completed. In this class of work more than a knowledge of electricity is required. It becomes essential to have a thorough knowledge of steam engineering, track and pole line construction as well. He should be as well able to choose the best engine and boiler for a given set of conditions, and to install and operate them economically, as he is able to choose the best dynamo, motor, line wire or lightning arrester. A practical knowledge of building foundations, laying out railway curves, and running pole lines, is to this engineer a matter of greatest importance.

The next distinct class of electrical engineers I would recognize, are designing engineers, who rather have to do with the manufacture of electric apparatus, than its installation. Such men design and superintend the construction of the apparatus put on the market by the several manufacturing firms, but rarely also have to do with steam engines, track construction, or pole lines. To this second class, a correct knowledge of machine design is of equal importance with a knowledge of magnetism and electricity, and it was perhaps of such men that Lord Kelvin was thinking when he said an electrical engineer should be nine-tenths mechanical and one-tenth electrical.

The third class of engineers are employed by standardizing bureaus, and in laboratories, to make tests of electric and magnetic constants, calibrate, instruments, etc. For such work neither a knowledge of pole lines, foundations, or machine design, is so important as familiarity with delicate methods of measurement and skill in manipulating sensitive instruments. It would seem best then to shape the course in any electro-technical school, as far as possible, to meet the requirements of these distinct classes of engineers.

The proportions of the three kinds I have named vary greatly in different parts of the country. To meet the immediate home demand for engineers, I believe our Western schools of engineering must make a specialty of training installing engineers. In the East the case is different. More men are employed by manufacturing firms, testing and standardizing bureaus, than by construction and engineering companies, so that the course given in the Eastern schools of engineering, and which are largely for the designing engineer, are justified.

A synopsis was then given of the course of instruction in electrical engineering at the University of Nebraska, the electrical equipment of which was declared by Prof. Thurston some months ago to be the finest, considering its size, in the United States, and the author closed as follows:

No attempt has as yet been made to teach telegraphy practically, and as we have here some members who have had much experience in practical telegraphy, I hope they will express their opinions as to the advisability of introducing it into electro-technical schools. Some declare it properly belongs to engineering, and others contend, with much truth, I think, that it properly belongs to a trade school. Similarly with wiring, electroplating and electrotyping. Is a practical knowledge and skill in them to be gotten in or out of the school?

THE TECHNICAL EDUCATION OF THE ELECTRICAL ENGINEER.[1]

BY PROF. DUGALD C. JACKSON.

PERHAPS it would be well to call my subject the "College Education of the Electrical Engineer," for it is strictly of the technical college course that I shall speak. We can truly affirm that the technical education of an engineer does not end until his work is ended, and the college course is but the commencement of it. It is neither possible nor desirable that the courses of study of electrical engineering students in the various schools should be alike, but a certain unity of purpose and treatment should be observed, and all can profit by the suggestions made by the practical man. With this in view, I present the subject to your attention as it is looked upon at the Engineering School of the University of Wisconsin. There is no originality claimed for the ideas presented, as they are based upon the recorded experience of some of the country's most successful practical men, and are virtually followed in such other engineering schools as make their courses thoroughly practical, and therefore, in the true sense, professional.

In order to enter the freshman class of the best engineering schools, the applicant must have a thorough common school education, including mathematics through ordinary algebra, a fair knowledge of English, a reading acquaintance with German or French, a little elementary physics and chemistry. In order that an engineer may use his abilities and training most advantageously, he should have a good general education, including a fair knowledge of literature, history, economics and certain elements of law. To have an average chance of proving successful, an electrical engineer must be well grounded in three sciences besides those gained in the common schools, and which cannot be classed as engineering. These are: Higher mathematics, as far as it may be practically applied in engineering; chemistry and physics (including elementary electricity and magnetism).

At the University of Wisconsin, during the first year the student is given a course of four subjects, continuing through the year. These are: 1st, English and rhetoric, with such reference to technical forms as seems desirable so early in the course; 2d, mathematics, beginning with higher algebra, passing through trigonometry and descriptive geometry, and into analytical geometry; 3d, advanced French or German, grammar and reader; 4th, manual training. In the latter, which continues during the following two years, we do not think it necessary or desirable for the student to spend sufficient time during his course to become a carpenter, machinist, blacksmith or foundryman. His future calling will probably not demand that his wages be earned in any of these trades; but they are tributary to his profession, and he must have an intelligent mastery of the tools. and an appreciation of shop requirements. Mathematics are also continued through the second and third year, during which time analytical geometry, calculus and applied mechanics are passed through. All mathematics are taught with special view to future *practical* applications, and good use is made of the laboratory in applied mechanics. During the second year of the course, elementary chemistry and physics are disposed of, and here again the laboratory is put to good service. At the same time, work in draughting and the elementary designs of machines is begun. The third year is about half, and the fourth year wholly, devoted to what may properly be called professional studies.

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[6] Prof. Huxley.

[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, June 7, 1892.

It may here be asked, Of what use is the severely specialized education to the successful student in the engineering courses? The graduate does not become an engineer merely because he has successfully met the college examination. College cannot make an engineer, however practical the course of study may be. Practice has made thousands of good ones without the aid of the college, but I venture to say that these would frequently have become more eminent if they had received a thorough technical college course. While theory alone, wherever learned, cannot make a practical man, it is the one who can follow the guide of theory along the paths of practical work and experience, who makes the fully developed engineer. In order, however, that neither theory nor practice may lead him astray, he must have a *well-educated common sense.*

The true object of the technical college is to teach the fundamental theories, with a common sense view to their practical applications, in such a way as to aid in a diagnosis, not by the application of a mathematical formula, but by comparing the accumulated experience of the practical world. Take two young men of equally *good* ability and equal age; put one through a thorough technical college course and the other through an apprenticeship of the same length of time. Finally, put them side by side in a working position, where they must work out their own salvation, and the college man will usually have more ambition and adaptability, and will outstrip his mate, though perhaps not at once. The college man may fall behind at first, but, having worked through the transition period, he will prove the winner. I venture to say this is the well-nigh universal experience of those who have had the opportunity of dispassionately trying the experiment.

It is comparatively easy to properly teach the fundamental theories; hence it is so frequently overdone. It is not so easy to educate the judgment of a student in electrical engineering, whose entire knowledge of his future profession has been acquired from the electric bells in his father's house, and who may never have examined a dynamo or storage battery until he visited the college laboratories. But it is wonderful how rapidly such students, when of good timber, absorb a beginner's information and a thirst for investigation. In this part of the student's education, the manufacturers and large users of electrical apparatus, who have become directly or indirectly interested in the work of the graduates, can assist with little direct inconvenience and much indirect advantage. In a properly organized technical school, as shown above, the student gains his fundamental theory during the first three years, and, if of good timber, he will absorb much of the practical methods of thought required for successful afterwork. Moreover, a considerable part of the third year is spent in practical instruction. As the fourth year is wholly spent in practical training; or the education of the common sense, the student must have some acquaintance with the methods of commercial work before entering it, in order that he may properly profit by the instruction. It is impossible for many, and doubtless undesirable for the majority, to take a year from the midst of their college course for outside work. The summer vacation between the third and fourth year should, therefore, be occupied in some such employment as wireman on electric light or telephone construction, or better, in the station and repair-room of an electric railway, under the eye of an appreciative superintendent. Three months spent in this work may seem very little, but it will do a deal of good in giving an apt student a fair idea of how far exact formulas will carry him. It is only by the generous co-operation of employers, that students can obtain this summer's work. At first thought it appears that the employer gains no advantage from it, but upon careful consideration, an advantage is evident. To begin with, the properly trained student will not prove useless during the summer, and the satisfactory one will usually find employment after graduation, with the interests of those who afforded him summer work, and who thus gain the benefit of his greater advancement during his last year at college. In a similar manner, the manufacturer gains an advantage from placing his apparatus in the technical school laboratories for *proper* use in instruction.

We can now usefully inquire into the specialized work that should be prescribed for the average electrical engineering student during his last two years at college. Up to this point, students in mechanical and electrical engineering courses have received virtually the same instruction. Here, we hold, with several others, their paths should diverge. The student of mechanical engineering goes into careful study of shop practice, designing and utilizing various types of machinery, and similar subjects. The electrical engineering student must receive a good working knowledge of the problems of the mechanical engineer, but he must above all be trained in the practical problems of electrical engineering. He, therefore, goes into a study of that which will aid most in making him truly an electrical engineer. His knowledge must all be based on mechanical laws, but he must be much more than one-tenth electrical.

Before reaching his truly professional studies, the student should gain, during his course in physics, a common sense grasp of the elementary notions of electricity and magnetism, and of the "all-pervading law of Ohm." The latter can be properly enforced in the laboratory by placing in the student's hands ordinary electrical instruments, such as bridges, galvanometers, amperemeters, voltmeters, etc. Before beginning his specialized work, the student's knowledge of Ohm's law and its common results should have become almost instinctive.

With due regard for his preparation, it seems best to arrange the professional studies for the average electrical engineering student in four divisions, thus:

1st. Electromagnetism and its application to practical uses, with special reference to dynamos and motors.

2d. Electro-chemistry (including primary and secondary batteries) and electro-metallurgy.

3d. Alternating currents and alternating current machinery, including dynamos, converters, condensers, etc.

4th. The special application of the preceding divisions in electric light, power, railway, mining and other types of plants.

The last division is allotted about twice the amount of time given to each of the others.

While higher mathematics is a useful aid in each of the divisions, its limitations as an agent must be carefully set forth in the class-room and laboratory. For the purpose of educating the judgment and fully defining the limitations of theories and mathematical deductions, the laboratory is indispensable. As much as one-half of the total time spent by the student under the direct instruction of the professors of electrical engineering, should be devoted to the laboratory. This work, moreover, should, as far as possible, deal with commercial instruments and machinery, and actually follow the methods of testing and research used in practice. Physics, chemistry, mechanics, steam engine, hydraulics, dynamos, electrolysis, alternating currents, and other subjects, should all be properly represented by a commercial laboratory equipment, which is made useful in every-day instruction under the direction of a man who has had experience in similar commercial work.

The student who satisfactorily completes a *proper* professional course at college, whether laid down in the college catalogue or carefully elected from that prescribed, is not likely to become one who "turns out results like a cornsheller, and never grows wiser or better, tho' it grinds a thousand bushels of them."

PRACTICAL NOTES ON THE ELECTROLYTIC REFINING OF COPPER.[1]

BY F. B. BADT.

It is the object of this paper to give a few practical data in relation to American practice, and to give a short description of the processes in vogue in this country. While the writer has erected some of the largest copper refineries in the United States, and examined a few of the other plants, the data which the writer submits in the following are not claimed to be either complete or to be absolutely correct. The writer has endeavored to tabulate the electrolytic copper refineries in the United States.

In the following we give a list of electrolytic copper refineries in the United States. It shows us that there are at present 36 dynamos of a total capacity of 1,814 kilowatts used for the electrolytic refining of copper, and that the total output of these refineries (when all are completed) will amount to 3,650 tons per month, or 43,800 tons per year. A capital of over $1,000,000 is invested in these refineries.

The Census Report, dated Washington, D. C., July 15, 1891, shows the United States to be the largest producer of copper in the world, its product for the year 1889 being 226,055,962 pounds, or 113,028 (short) tons. The total expenditures involved in this production were $12,062,180, of which there was paid in wages, $6,096,025; in salaries, $120,896; to contractors, $334,443; for materials and supplies, $4,067,970; and for taxes, rent, etc., $1,442,846, the total capital invested being $62,623,228, and the total number of employees, exclusive of office force, 8,721. The same Census Report gives some statistics on "copper refining," but unfortunately fails to state how much copper was refined by the electrolytic process.

The returns cover establishments which produced 159,693,252 pounds (79,847 tons) of refined copper, valued at $19,686,561.86.

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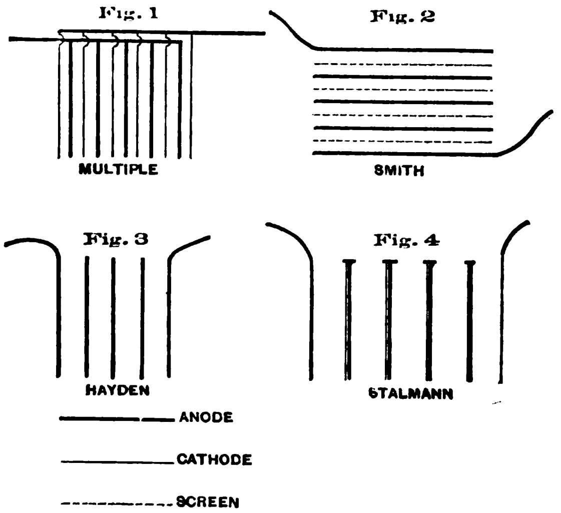
[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, June 6, 7 and 8, 1892.

Hence if our list is approximately correct only about 25,000 tons out of 79,847 tons of refined copper were treated electrolytically.

In the table below, I mention, in the fourth column, the names of certain processes in vogue in the United States, and it might be well to show the main features of each. The crude material used in the anodes is black copper, or blister copper, containing from 97 per cent. to 98 per cent. of copper. The electrolyte is a solution of sulphate of copper. In some processes refined copper is a by-product only, especially when it appears in a concentrated form in the mattes of lead smelters and refiners. In the process which we call the "multiple process," anodes and cathodes in each vat are arranged in multiple, in about the same manner as the plates in a storage cell. (See Fig. 1.) In this process there is usually one more cathode than there are anodes. The electrodes are suspended in a vertical position in wooden vats usually lined with lead. The vats themselves may be arranged either in series, in multiple, or in multiple series. For simplicity's sake and for numerous other reasons well known to the electrical engineer, an arrangement of vats in single series is most advantageous.



METHODS OF COPPER REFINING.

Another process is the "Smith process" (United States patent No. 393,526, Nov. 27, 1888.) In this process there are no cathodes of pure copper. The plates of black copper (anodes) are not suspended vertically in the solution, but are placed horizontally. As it would not be practical in many places to cast the plates large enough to give a sufficient amount of surface, several plates are placed side by side so as to form one large plate. These layers are then placed one above the other at a distance of about 1½ inches, the layers being supported by strips of wood running lengthwise of the vat. The top plate is connected as an anode to the generator, and the other pole of the dynamo with the bottom plate. The spaces between the plates are filled with the solution of sulphate of copper, which forms the only connection between the plates. The copper is dissolved from the under surface of each layer and deposited on the upper surface of the next layer below. The insoluble foreign matters in the copper, including gold and silver, fall upon screens of cotton cloth which are stretched between each two layers. The process is kept up until all the black copper is dissolved and nothing remains but plates of electrolytic copper. Fig. 2 shows the relative position of plates in one vat. The inventor claims several important advantages over the common vertical multiple arrangement. He claims that the silver or other foreign insoluble matter is removed, that the space required for a given amount of depositing and the amount of solution required are relatively small, that the connection between the plates in one tank is made by the solution only and that the copper is easily handled and prepared for the vats. Smith arranges all vats in series.

Another process mentioned in the list is the "Hayden" (Fig. 3, United States patent No. 465,525, Dec. 22, 1891). The Hayden process differs materially from that of the Smith only in that he places his plates in vertical position instead of placing them horizontally, and that he does not use any screens. Hayden also arranges his vats in series.

LIST OF ELECTROLYTIC COPPER REFINERIES IN THE UNITED STATES.

Name of company.	Generators.	Number of of vats.	Process (arrangement of vats).	Output in electrolytic copper per month, tons.	Remarks.
1. Anaconda Mining Company, Anaconda, Mont.	5 Edison—60 volts, 1,100 amperes.	320	Partly multiple, partly Stalmann.	350	Plant being extended for ultimate capacity of 900 tons per month.
2. American Nickel Works (Jos. Wharton), Camden, N. J.	1 Excelsior—6 volts, 1,000 amperes.	48 in series.	Multiple..................	30*	By-product.
3. Balbach Smelting and Refining Company, Newark, N. J.	7 Excelsior—15 volts, 2,000 amperes. 1 Excelsior—30 volts, 3,000 amperes.	7 series of 48, 1 series of 96	Multiple (18 anodes, 81 cathodes).	650	They refine the product of the Oxford Copper Co., whose smelters are in New Jersey, and who are general purchasers of copper ores, matte and bullion.
4. Baltimore Copper Smelting and Rolling Company, Baltimore, Md.	6 Edison*—150 volts, 400 amperes.	....	Hayden...................	800	Generators have sectional fields which can be plugged for different voltages.
5. Baltimore Refining Company. Baltimore, Md.	2 Edison—80 volts, 700 amperes.	....	Hayden...................	300	
6. Boston & Montana Consolidated Copper and Silver Mining Company, Great Falls, Mont.	3 Thomson-Houston, multipolar separately excited, 165 volts, 1,000 amperes.	288	Multiple (19 anodes, 19 cathodes).	550	Plant in construction. Dynamo capacity in excess of present requirements.
7. Bridgeport Copper Company, Bridgeport, Conn.	1 Thomson-Houston, 1 Mather, 1 Edison—150 volts, 400 amperes.	3 series of 10	Hayden (100 electrodes in each vat).	400*	They refine the entire product (black copper) of the Parrott Silver and Copper Company, Butte, Mont.
8. Chicago Copper Refining Company, Blue Island, Ill.	2 Edison—80 volts, 800 amperes.	165	Multiple................	150	
9. Electrolytic Copper Company, Ansonia, Conn.	3 Mather—100 volts, 300 amperes	75	Smith....................	100	
10. Lewissohn Bros.† Pawtucket, R. I.	1 Excelsior—15 volts, 2,200 amperes.	60 in series.	Multiple (19 anodes, 19 cathodes).	110	
11. Omaha & Grant Smelting Works, Omaha, Neb.	1 Excelsior—6 volts, 1,000 amperes.	48 in series.	Multiple..................	30	
12. Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.	....	....	Smith....................	30*	By-product.
13. St. Louis Smelting and Refining Company, Cheltenham, St. Louis, Mo.	1 Excelsior—16 volts, 2,400 amperes.	48 in series.	Multiple....	60*	This plant is operated in connection with an electrolytic silver refinery, using the Moebius process.
14. Washburn, Moen & Co., Worcester, Mass.	....	....	....	90	Plant burnt, being erected.

† Agents for the following mining companies: Boston & Montana Consolidated Copper and Silver Mining Company, Montana; Butte & Boston Mining Company, Montana; Arizona Copper Company, Arizona; Huron Copper Mining Company, Lake Superior. Mich.; Tamarack Mining Company, Lake Superior, Mich.; Osceola Mining Company, Lake Superior, Mich.; Kearsarge Mining Company, Lake Superior, Mich.; Santa Fé Copper Company, New Mexico; Peninsula Copper Mining Company, Lake Superior, Mich.

Another inventor, Stalmann (United States patent No. 467,350, Jan. 19, 1892, and No. 467,484, Jan. 19, 1892), practically uses the same process as Hayden, only, instead of using single plates he uses, with the exception of the initial anode and the terminal cathode, pairs of plates of crude and refined material, but brings the two plates together by connecting them by one or more bolts or rivets so that they become practically a pair of anode and cathode plates with no electrolytic solution between them (Fig. 4).

One pound of copper will be deposited in one hour theoretically, by a little less than 386 amperes out of a solution of sulphate of copper. If we, therefore, pass 386 amperes through one vat, we will deposit one pound every hour and if we pass the same current through a series of 100 vats, we will deposit 100 pounds each hour. The amount of power expended in each vat, however, is $C^2 \times R$, but as it is always possible to reduce the resistance of a vat by increasing the surface of the plates, we can greatly reduce the amount of power required for the same output in copper per horse power hour. We may also reduce the ampereage for a given production by joining more vats in series, or we may combine both methods.

It is therefore always possible to largely reduce the expenditure of electrical energy, and consequently that of the motive power. As a matter of fact, theoretically, any amount of copper may be refined with any given horse power, but as soon as we attempt to largely increase the production of copper with a given power, we find it necessary to largely increase the size and number of vats and the quantity of copper under treatment. These conditions have been thoroughly examined, and the laws governing them have been explained in the several hand-books extant.

Another important item in order to obtain a pure deposit is the density of the current. American copper refiners usually adopt 10 amperes per square foot of active cathode surface as a maximum. I am told, however, that some of the refineries operating on the "Series" processes go even beyond 15 amperes per square foot, which may account for certain impurities found in the electrolytic copper and for a greater efficiency of the plant; that is, a larger output of copper for a given number of vats and amount of copper under treatment.

High voltage in an electrolytic plant of course means considerable saving or less drop in conductors, less trouble from poor contacts, etc., and it is probable that for these reasons the so-called series processes show a greater efficiency per given horse power than the processes employing electrodes in multiple.

Another important item for the obtaining of pure deposits is a good circulation of the electrolyte. This insures a uniform specific resistance in the solution between the parts of the plates.

In American practice, the electrolyte is sometimes kept in circulation by arranging the tanks on the cascade plan, and have each higher vat siphon through a pipe whose orifice is near the bottom of the next lower vat. A better plan now usually adopted is to have a trough run through the whole refinery, and have each vat fed independently by means of a rubber hose. The electrolyte is raised from the collecting tank into the troughs by means of lead pumps or steam injectors. Both, however, are objectionable. The pumps are always getting out of order, and the steam injector means waste of steam, besides having the disadvantage of putting too much moisture into the electrolyte, which again necessitates the adding of free acid continually. A better plan is to have two collecting tanks, which are to be used alternately. Just as soon as one is full it is made air-tight, and a small air compressor driven by an electric motor compresses the air above the solution and drives the solution under a pressure of, say, 25 pounds through a pipe up into the troughs. Smith claims that in his arrangement no artificial circulation of the electrolyte is required.

We might mention another incidental advantage of the multiple process over the series processes. Some of the patentees claim one-fourth of a cent per pound of refined copper as a royalty. In one instance one plant gives the patentee, under this arrangement, an income of over $100 per day. Taking this in combination with the very doubtful advantages claimed for the series process, we need not wonder that there exists prejudice against erecting electrolytic refineries employing these patented operations.

I could enumerate a long list of defects that exist to-day in almost all of the electrolytic refineries, and which may all be traced to one cause, and that is, the imperfect knowledge of the refiners, of matters electrical. As a matter of fact, all the experiences which we have gone through for the last ten years in constructing electric light and power plants, have been of no benefit, it seems, to most electrolytic refiners. Even in the few installations where a voltmeter is used to indicate the proper working condition of the vats. this voltmeter is carried by two men from vat to vat, and the voltage of each vat is taken in this cumbersome manner.

In a plant just being erected, the writer proposes the erection of a potential board in the office of the superintendent. Both terminals of each vat are to be connected with two contact points of the potential board, and a voltmeter is to be so arranged that by simply turning a switch handle the potential of each vat can be taken almost instantaneously. One of the occurrences which has to be guarded against is the short-circuiting of an anode and a cathode, which in the multiple plan means the short-circuiting of a whole vat. Such an occurrence should be detected immediately, as otherwise the contents of the vat may be spoiled. The author proposed for a plant just being erected an electric tell-tale in connection with the potential board.

Some of the electrolytic refineries in the United States buy copper matte of from 45 to 54 per cent. of copper from the mining companies. In these cases they own their own smelters, resmelt the copper matte, producing black copper of from 97 to 98 per cent. of copper. This black copper is then cast into anodes and subjected to the electrolytic process. Other refineries buy the black copper direct from the smelters owned by the mining companies. For instance, the Bridgeport Copper Company, of Bridgeport, Conn., buys the entire product of the Parrott Silver and Copper Company, of Butte, Mont., as black copper.

There is another matter which should be mentioned, as it is very often misunderstood by the public and the electric companies. If copper matte contains, according to the assay, 30 ounces of silver or less per ton of matte, no extra charge is made for the silver, but the copper matte is sold at the reigning market price. If it contains, however, over 30 ounces, the silver is to be paid in accordance with the assay. Thirty ounces of silver per ton of matte, of course, means almost double that amount per ton of electrolytic copper. It can easily be seen that electrolytic refineries prefer to buy copper matte containing just a trifle less than 30 ounces of silver per ton.

There are quite a number of points which need the attention of electrolytic copper refiners. There are, for instance, only a few of the refineries which manufacture their own sulphate of copper, but buy it at high rates in the market. Sometimes the cost of freight and haulage doubles its cost. Each copper refinery should have a little installation of its own for the manufacturing of the necessary sulphate of copper, which it can do at a small fraction of what it has to pay for it. The same holds good in relation to the refining of the slime or mud which collects at the bottom of the vats, and which contains the precious metals. Each copper refinery should have its own little plant for the refining of the mud. These little installations can be run at a small expense in connection with copper refineries, and it is almost nonsensical to have other concerns make large sums of money which could be saved by the refiner himself.

A few words as to electric generators may not be out of place. The author prefers separately excited machines for the reason that they cannot be reversed and for other incidental advantages. When water-power is used as prime mover a good deal of trouble has been experienced in the regulation of the wheels. As a matter of fact there is no water governor in existence which will regulate so perfectly as the governor of a modern automatic engine under varying loads. By running all the exciters from an independent prime mover (either water or steam) the strength of the fields of the generators will be uniform at all times whether there are fluctuations in the external circuit or not; the strength of the field of the generators which, with self-exciting machines, is subject to the fluctuations in the external circuit, and is a variable, becomes a constant. The author proposed this arrangement over three years ago for railway and power stations with the very best results.

There are other processes which contemplate the extraction of copper direct from the ores by means of electrolysis. The best known are the "Siemens" and "Hoepfner." If we are correctly informed the Siemens process is now being used in one experimental plant only, which is used by the Siemens firm. This is at Martinicken Fields, near Berlin. Dr. Hoepfner's process, it is claimed, is now in operation in three plants; one at Schwarzenberg, which began operations in September, 1890, and two others about which very little has been published. Dr. Hoepfner uses in his process a cuprous chloride solution, out of which a current of one ampere will deposit 2.35 grammes per hour, while out of a solution of sulphate of copper, only one-half of this amount of copper can be deposited per unit of current per hour.

We finally give below the approximate cost of a refinery with a capacity of 1,000,000 pounds of electrolytic copper per month:

Building	$30,000
Pavement (asphalt)	2,000
Pipes for steam heating	4,000
Vats	6,000
Lead for lining vats, collecting tanks and troughs	28,000
Lead burning	1,500
Copper conductors	11,000
Rails for overhead blocks for handling plates	2,000
Sulphate of copper	3,500
Sulphuric acid	1,000
Steam injectors or pumps or air compressors	1,000
Electric generators, switchboard, instruments	30,000
Shafting and belting	3,000
Total	$123,000

To this sum must be added the copper under treatment, which in this case will amount to at least $80,000, and, if a steam plant should be required, another $20,000 must be added, bringing the total of this plant up to $223,000. The above items include labor of erection, but do not include freights. These figures, although approximate and true only under certain conditions, will demonstrate that electrolytic copper refineries are expensive plants, and should be erected on carefully prepared plans and under the supervision of responsible and competent engineers.

THE WASHINGTON CONSTRUCTION CO. are installing a 200-light Edison plant at River View, one of the many Washington river resorts.

LONG-DISTANCE TRANSMISSION FOR LIGHTING AND POWER.[1]

BY CHARLES F. SCOTT.

A DESCRIPTION is here given of two plants, one for lighting and the other for the transmission of power. The conditions which have been met include a very considerable distance, extreme difficulties of climate and roughness of country, exacting requirements in continuity of service, and a pressure above that ordinarily used in the class of machines employed. The plants to be described are the first of their type installed in this country, and the apparatus in the power plant is of a kind that has not been heretofore used. The type and construction of the machines, and the arrangement of apparatus are new in many particulars, and as they have contributed largely to successful operation they will be described with some minuteness. Alternating current machinery is employed, constructed by the Westinghouse Electric and Manufacturing Company, the pioneer company in alternating work in this country.

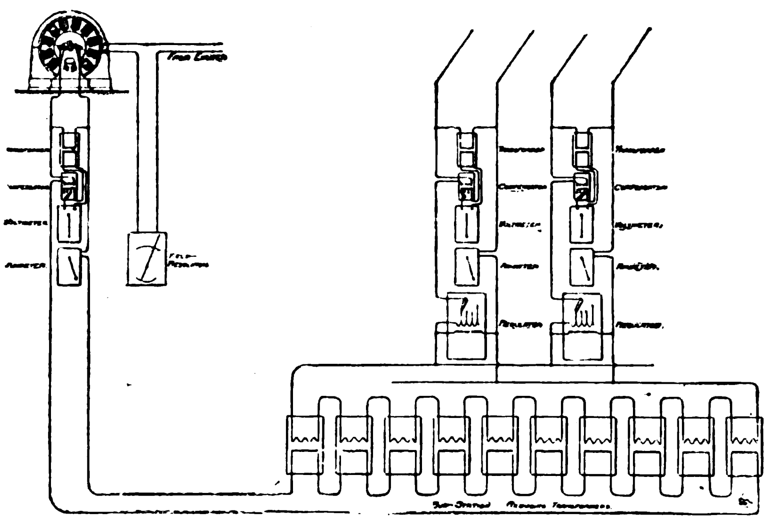


FIG. 1.

The lighting plant was first installed. It is operated by the Willamette Falls Electric Company, of Portland, Ore. The falls of the Willamette River at Oregon City, in the combined points of size, accessibility and nearness to the seaport, are unequaled. These falls, estimated at from 200,000 to 250,000 h. p., are about 13 miles from Portland, and it requires but a moment's thought to appreciate the value of an agent which can make this power available in the city.

The Willamette River is about one-quarter of a mile wide, and the fall is about 40 feet. The present station is located on an island at the middle of the river. Victor wheels of 300 h. p. are geared to horizontal shafts, from which the dynamo belts pass to an upper floor at an angle of 45 degrees. Two alternating current dynamos for incandescent lighting are driven by each wheel. The current, at a pressure of 4,000 volts, passes directly to the line of No. 4 B. and S. wire, which is carried on ordinary double-petticoat glass insulators across the level country to a sub-station in Portland. The current is received at 3,300 volts by transformers in the sub-station and is reduced to 1,100 volts for distribution by various circuits through the city to ordinary transformers, by which it is reduced to 50 or 100 volts. See Fig. 1.

When the apparatus was designed, it was not considered practicable to generate 4,000 volts with the ordinary type of machine, in which the wire is wound upon the surface of the armature, on account of the difficulty of insulating for more than 1,000 or 2,000 volts. The work was undertaken with a new type of armature, which is specially noteworthy, as it has rendered high potentials practicable in a machine of simple construction.

The field of the dynamo is of the ordinary type of alternating current machine in use in this country. The casting is circular in form, with 12 inwardly projecting poles of laminated iron, on which the field coils are placed.

The armature, Fig. 2, is built up of laminated discs, which are punched with 12 T-shaped teeth. The armature coils are wound in a lathe, are carefully taped and insulated, and are then placed over the teeth and sprung in under the projections. The space between adjacent coils is filled by a block of wood, which holds them in place securely. The field current is supplied from a direct current machine, and the main current is taken from two collecting rings on the armature shaft.

The reducing transformers are placed in a vault in the substation at the city. They are arranged in banks, or units of 10. Each bank is supplied by a separate dynamo, and has a capacity of 1,250 16 c. p. lights. The coils of the transformers are separately wound and taped, and are separated from one another and from the iron by strips of wood, Fig. 3. The primaries are connected in series for receiving 3,300 volts, and the secondaries are in series for delivering 1,100 volts, so that there are 330 volts in the primary, and 110 volts in the secondary of each converter. This method of connection throws small differences of potential in any single coil and permits the use of conductors of good size. The efficiency of the transformer at full load is 96 per cent.

The operation of the system is simple. The voltmeter or potential indicator is supplied by the secondary of a converter reducing in the ratio of 30 to 1. In the voltmeter circuit, Fig. 1, there is placed a compensator, which is a small transformer with its primary in series with the main circuit, and its secondary in series with the voltmeter circuit, and connected in such a way that the compensator pressure, which is proportional to the main current, is opposed to that of the converter. The compensator is so adjusted as to introduce into the voltmeter circuit a counter E. M. F. proportional to the loss in the conductors, so that the voltmeter indicates the potential at the distant end of the line. The compensator effects the same result as pressure wires run from the point of supply back to the station. The E. M. F. at the dynamo is adjusted for each load by regulating the field current so that the voltmeter shows the proper indication, thus keeping the pressure at the sub-station constant at 3,300 volts. The pressure at the dynamo is slightly in excess of this at light loads, and is increased to 4,000 volts at full load, to cover the loss of transmission. The secondary current from the reducing transformers is treated as if it were received directly from a dynamo. On each supply circuit from the station there is a voltmeter with a compensator set for the loss in this circuit. The exact adjustment of E. M. F. on a circuit is made by a regulator, consisting of a transformer with its primary connected directly across the main terminals, and a secondary divided into small sections, each having an E. M. F. equal to one per cent. of the primary. Any number of these sections may be placed in series with the supply circuit, thus varying the E. M. F. at will. This form of regulator

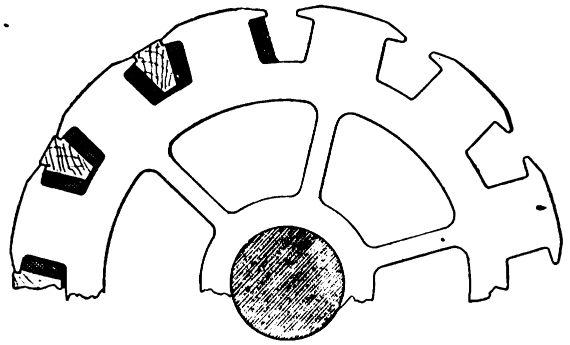


FIG. 2.

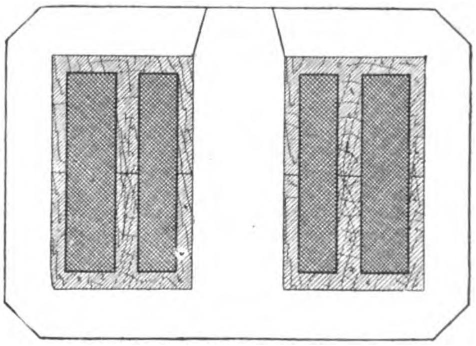


FIG. 3.

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[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, Ill., June 6, 7 and 8, 1892.

is of high efficiency, as it converts but a small percentage of the total energy, and the loss is a small fraction of this percentage.

The plant was first installed with two incandescent machines and started nearly two years ago. Since that time, five additional machines have been added, so that there are now seven, each with a capacity for supplying 1,250 16 c. p. lights, in Portland. The total capacity is 8,750 lights. The dynamos run admirably. One explanation of the success of the plant is the intelligent policy of the general manager, in harmony with his statement that, "It is not the first cost which counts, but the cost of throwing out and replacing apparatus."

The same policy has happily governed the installation of the second plant to be described—the power plant. This is located near Telluride, Col., and is owned by Mr. L. L. Nunn. The Gold King mill requires power for operating its crushers and stamps, and fuel can come only from long distances at enormous cost. A few miles from the mill there is a water-power, but the country between the two points is steep and rough, and for many months in the year is covered with snow. Electricity is the one means of getting the power from its source to the mill. The conditions are of the most favorable character for demonstrating the value and possibility of electrical transmission.

In this plant a Pelton wheel receiving water through a two-foot steel pipe, under a head of 320 feet, drives an alternating current generator. The current is carried over a line of bare wire to the mill, which is nearly three miles distant, and drives an alternating current synchronous motor of 100 h. p. The generator and motor are machines of the same size and form of construction as the dynamos at Portland, already described, and differ from these only in some minor modifications.

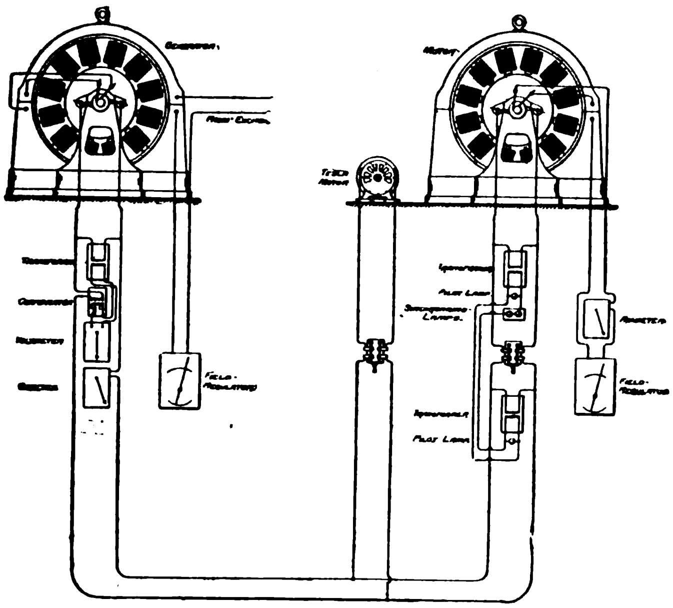

FIG. 4.

The generator is provided with a composite field winding, Fig. 4. A part of the magnets are excited by direct current from a separate machine, and the rest are excited by a current from the generator armature, which is proportional to the main current and is commutated by the equivalent of a two-part commutator. The adjustment is such that the E. M. F. on the main terminals rises as the current delivered by the machine increases, compensating for line losses and keeping the pressure at the motor 3,000 volts. The speed is 833 revolutions, giving 10,000 alternations per minute. The switchboard and regulating appliances are similar to those in the station at Portland. Ordinarily no adjustment is required after the machine is started, and the attendant has little to do besides looking after the mechanical running of the apparatus.

The motor, Fig. 5, is similar to the generator except in the manner of exciting the fields. The field current is obtained, not from a separate machine, but a second winding parallel with the main coils around the teeth of the armature. This current is commutated and passes through the field coils.

A motor of the synchronous type requires an auxiliary device for starting, which, in the present plant, is a small motor—a special modification of the Tesla type, Fig. 6. This motor comes quickly to its normal speed and then has ample capacity for bringing the armature of the large motor up to speed. Both of the machines are belted to a countershaft, and the ratio of the pulleys is such that the speed of the large motor is a little greater than that of the generator. The large motor is then excited and runs as a self-exciting alternating current dynamo at the normal E. M. F. of the circuit. The small motor is then switched off and the speed of the large machine gradually falls until it is approximately equal to that of the generator. The relation between the speeds of the two machines is indicated by the fluctuation in the intensity of lamps, which are connected in series with the secondaries of two converters, whose primaries are connected with the generator and motor respectively. At the time of slow variation and proper phase relation the machines are connected by closing the switch. The small motor is disconnected by its friction clutch and comes to rest, and the load is then thrown upon the large motor by a second clutch. The operation of starting requires but one man, and is accomplished in about two minutes.

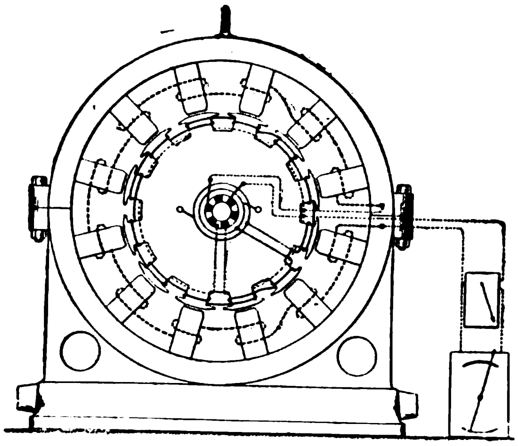

FIG. 5.

The connection of the motor to the generator is not a delicate operation. If the motor is running above synchronous speed at the time of connection with the generator it instantly adapts itself to the proper speed. If the motor speed is slightly lower than that of the generator it may fall into step when the switch is closed, but if it be running considerably slower it will not come into synchronism, but will further decrease in speed. When this occurs, the switch of the large motor is opened and that of the starting motor is closed, bringing the machine up to full speed again without any injury to the apparatus. If the E. M. F. upon each of the machines before connecting them be 3,000 volts it will remain unchanged when they are connected. If the field current of either machine be increased the E. M. F. will be raised, but the field current of the other machine may be lowered and the resulting E. M. F. made equal to 3,000 volts. The current flowing between the machines depends upon the relative field charges, and is least, whatever the load may be, when the two machines are equally, or very nearly equally, excited. The field current of either machine may be made zero, and the motor will still run, but with a greatly reduced capacity. In a test with machines of a smaller size the E. M. F. was 2,000 volts when the two field charges were equal. When the field charge of either machine was cut out it fell to 1,200 volts, and the current increased very considerably.

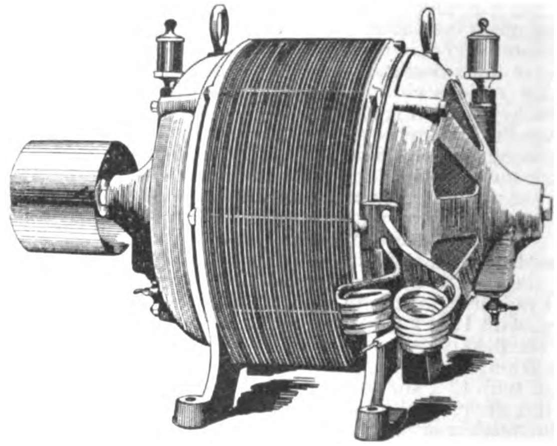

FIG. 6.

An efficiency test of the motor was made before shipment by driving a dynamo which was loaded. The current and E. M. F. received by the motor and delivered by the dynamo were measured and an allowance made for the loss in the dynamo. The full load efficiency in this way was found to be 93 per cent. In a test upon smaller machines of similar type the efficiency of the motor at full load was found to be 91.5 per cent. The efficiency of the synchronous motor system, leaving out loss in conductors, but including losses in generator and motor, in the plant for the delivery of 50 h. p. was found to be 83½ per cent. at full load, and 74 per cent. at half load.

Full load may be thrown on the motor suddenly. In the Gold King mill the stamps, which are operated by the motor, are usually left raised when the plant is stopped, in order to avoid the extra strain of lifting them when the plant is started. It sometimes happens that the stamps are left down and the motor is required to raise them all at once. When the clutch is thrown in, the current indicates that the load is considerably above the normal capacity of the motor, and yet it is started without difficulty or apparent strain.

The pole line runs from the power station up the mountain to a height of 2,500 feet, and then crosses a rough but comparatively level country to the mill. The line at some places is at an angle of 45 degrees, and many of the poles had to be set in solid rock. The surface of the snow in winter is occasionally at a level with the tops of the poles, and parts of the pole line are practically inaccessible during some months of the year. This region is peculiarly subjected to lightning discharges, and special precautions are necessary to protect the apparatus. In one instance there were 42 discharges of the lightning arresters in as many minutes.

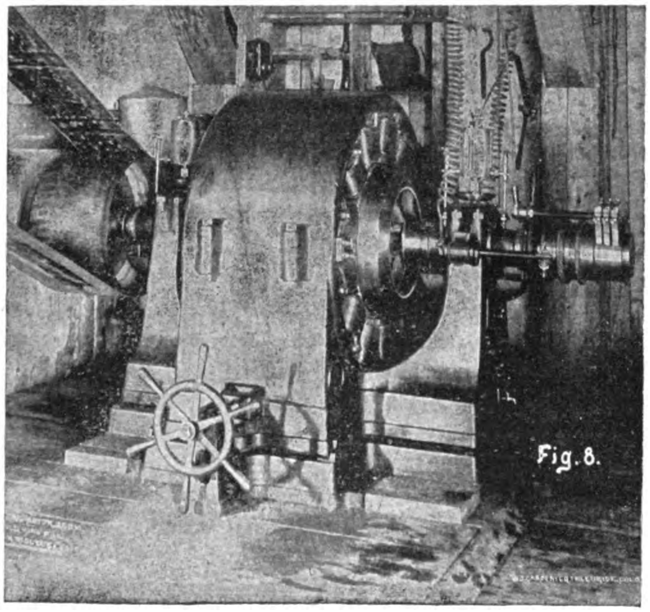
Fig. 8.

THE SYNCHRONOUS MOTOR IN THE GOLD KING MILL.

The plant was started for regular work in June of last year. An accurate record was kept from the middle of July to the first of May, showing the actual number and the length of the delays caused by electrical machinery. The aggregate time lost on account of the electrical apparatus was, by actual count, less than 48 hours during three-fourths of a year. Such a record as this, with a new type of machinery, in a country where line construction and maintenance are peculiarly difficult, with practically continuous service, with attendants who were not electricians, with a high voltage, a considerable distance and large power, places transmission by the alternating current synchronous system beyond the stage of experimental trial and gives it the stamp of commercial success.

This success is confirmed in a substantial way by the immediate extension of the plant. A 50 h. p. motor is now being installed at a mill a few miles from the Gold King. An order has been entered for a 750 h. p. generator to be located in the power station, and a 250 h. p. motor for operating a mill about 10 miles distant. Lighting at Telluride, eight miles from the station, which has been heretofore done on a small scale on a circuit from the power generator, is being extended. The large generator is of a new design, and is notable as it has more than three times the capacity of any alternating current dynamo previously made in this country. Two machines of this size have been running for some months for incandescent lighting in St. Louis.

This dynamo is of a type similar to the machines at Portland and Telluride. The field has 28 poles, requiring a speed of 570 revolutions for 16,000 alternations, the conditions of running at St. Louis, and 357 revolutions for 10,000, as it will be operated at Telluride. The armature has T-shaped teeth, as in smaller machines. The diameter of the armature is slightly over four feet and its length is about two feet. The total height of the machine is eight feet and its weight is 40,000 pounds. The electrical efficiency at full load is over 95 per cent.

The extension of alternating current working, both for lighting and power, by the use of larger machines is therefore already provided for. The extension to greater distances is largely a question of E. M. F. Nearly every one is familiar with the rapidity with which the cost of copper diminishes as the voltage is increased. If the cost be $100 with 500 volts it will be $25 at 1,000 volts, and $1 at 5,000 volts. The higher the tension, however, the greater the difficulty and cost of construction and the greater the liability to accident with apparatus and line. There are a few points in connection with this subject which may be noted without entering into a general consideration of it.

The smallest size of wire that can well be used for line work, on account of its mechanical strength, is about No. 6 B. & S. This wire will transmit with 20 per cent. loss 100 h. p. 10 miles at 4,000 volts, or twice the power half the distance. Unless these distances or powers are to be exceeded an increase in pressure would result in no saving in copper but simply in a less line loss, which is already not excessive.

The use of 4,000 volts at the motor and a line loss of 20 per cent requires an outlay for copper of only about 10 per cent. to 15 per cent. of the total cost of the plant when the distance is 10 miles. Unless, therefore, the cost of copper is to be an insignificant proportion of the total cost it is unnecessary to exceed this pressure unless the distance be greater than about 10 miles.

These simple considerations show that pressures practically the same as those employed in the plants which have been described are ample for considerable distances. The same type of apparatus which has been successful in them is available for larger capacities. The fundamental elements required for electrical transmission in a very wide range of cases have therefore been tried and their success demonstrated.

For considerably longer distances, where pressures higher than about 5,000 volts are required, good practice indicates the use of transformers for raising the pressure at the generator and reducing it at the motor, similar in general to those employed at Portland. The increased pressure thus available greatly reduces the cost of copper required, and this reduction must, of course, be more than sufficient to cover the cost of the transformers.

The alternating current motor has been one of the most complicated and difficult electrical problems, and yet the first large alternating current motor installed in this country excels direct current apparatus in simplicity of construction and operation, in perfection of regulation, and handles with simple sliding contacts, running for a week without adjustment, a pressure which with commutators is impracticable.

There is another class of alternating current apparatus to which no reference has been made. The multiphase, or Tesla system, which has attracted much attention of late, possesses the characteristics of this type of apparatus, which readily adapt it for combining simple construction with the use of high presures. There are also marked advantages in the characteristics of the motor which are of especial value where distribution of power is to be combined with transmission. Motors of this class are self-starting with load, and may be run either as synchronous motors or with one winding short-circuited and no commutator or brushes. The latter is the ideal motor in point of mechanical construction.

The simplicity, flexibility and range of the alternating current system make its possibilities the sole dependence of the largest enterprises, toward which the public and engineers are looking. The records of the plants at both Portland and Telluride, demonstrate that these possibilities are being realized, and that work in this field is fast passing from experimental investigation into practical electrical engineering.

UNIVERSITY OF WISCONSIN.

A DETAILED account of the electrical engineering course at the College of Mechanics and Engineering of the University of Wisconsin, at Madison, is given in the circular for 1892–3. The aim of the college is not to produce engineers, but men with great capacity for becoming engineers. A through curriculum is provided, under the direction of Dr. Davies and Prof. Jackson, in the theory of electricity, in addition to which the laboratory practice is made to conform with and illustrate in a thorough manner the instruction by text-books and lectures. Of the total number of hours given to instruction in the electrical engineering subcourses nearly one-half (about four hundred and fifty hours) is devoted to work in the laboratories. The results derived by students in the laboratory, together with a full description of the work performed, and the methods employed, are reported to the professor on blank forms furnished for the purpose.

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EDITORIAL ANNOUNCEMENTS.

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VOL. XIII. NEW YORK, JUNE 15, 1892. No. 215.

We have no sympathy with the cant of the day with reference to "practical men" if by this term is understood those who act without reference to well-established general laws and are only guided by empirical rules or undigested experience.—Joseph Henry.

PROF. HOUSTON ON CEREBRAL RADIATION.

FEW theories of modern times are more suggestive and full of scientific interest than that recently advanced by Prof. Edwin J. Houston as a possible explanation of hypnotism, telepathy, mesmerism and kindred phenomena, while the fact that its author is a man equally well known in the world of science and that of affairs, affords a striking instance of the catholicism of fin de siècle research. That a mysterious "something" exists, enabling one mind to exert absolute power over others apparently in tune with it is universally admitted, but the study of its nature has been too long left in the hands of visionaries. While Prof. Houston modestly confesses that his suggestions are incomplete, and, in fact, characterizes them as rather wild, they open an enormous field for labor upon lines already familiar to men skeptical as to spooks, but intensely alive to the importance of all that bears upon the questions of everyday life.

Postulating the existence of luminiferous ether capable of passing readily through the densest matter, Prof. Houston argues that cerebration, if attended by vibrations, must develop in this ether wave motions, having the brain atoms as centres; that is, the act of thought necessitates atomic disturbance and a consequent expenditure of energy. The various groupings of the brain cells would appear to correspond with certain combinations of thought, and vice versa; thus study, by causing the constant repetition of the same set of motions, gives the brain particles a tendency to form groups more or less permanent, which call up the particular train of thought to which they belong. The existence of this atomic vibration of the brain cells, while not distinctly proven, is far from unlikely, and, indeed, certain facts seem to point very strongly to its probability. A fracture of the skull, for instance, producing abnormal pressure on the brain will suspend cerebration until the pressure is relieved, when the patient usually takes up the thread of life from the moment when consciousness was lost, without regard to the intermediate lapse of time.

An active brain is, then, regarded as sending thought waves through the ether in all directions, like a conductor through which an oscillatory discharge is passing, and the possibility of the transference of specific cerebral vibration from it to a passive brain is explained by the action of sympathetic vibrations, as illustrated in the well-known experiments with tuning-forks and the phenomenon of the radiation of light. Electric resonance presents a still more striking instance of sympathetic vibration, where an oscillatory discharge from one conductor traverses space with the velocity of light, and, upon meeting a circuit so tuned as to be in consonance with the original conductor, sets up oscillations in this circuit identical with those that excited it.

If thought radiations partake of the nature of ether waves their phenomena should, naturally, correspond with those of thermal, luminous, electric or magnetic radiation, and it becomes possible to imagine the refraction of a complex train of thought, so to speak, by something corresponding to a prism; nay more, the author suggests even the remote possibility of obtaining photographic impressions of thought waves on a suitably sensitized plate or its equivalent, and the subsequent utilization of such a record to awaken in another brain thoughts identical with those recorded. The image thus produced would convey no more meaning to the eye than do the marks on the cylinder of a phonograph, but the idea of such an instrument is, after all, no more preposterous than that of the phonograph, or even the telephone, would have appeared one century ago.

Such, briefly outlined, is the theory that Prof. Houston, with many assurances that it is merely a suggestion, and, it may be, some misgivings that it is ahead of its time, has offered to scientists interested (and who is not?) in the countless phenomena of thought transference. That he should have sufficiently overcome his diffidence to make public the result of these speculations, in which, he says, he has indulged for a number of years, is a subject for congratulation; it is, however, to be hoped that he will not be content to stop at suggestions.

THE EDUCATION OF THE ELECTRICAL ENGINEER.

"As ye sow, so shall ye reap," is a maxim, the truth of which needs no exemplification. Its force, however, is nowhere more apparent than in everything that relates to educational matters. At the meeting of the Institute at Chicago two papers, one by Prof. D. C. Jackson, and another by Prof. R. B. Owens, were devoted to the discussion of the proper training for the electrical engineer, and the views expressed therein are worthy of the most serious consideration. It must be evident to any one at all acquainted with the requirements of active practice, that no school, however well equipped it may be with able teachers and complete laboratories, can turn out finished engineers ready to cope successfully with the new problems in electrical engineering which are daily presented; or, indeed, to plan immediately and carry out work even of the most general character. In this respect electrical engineering does not differ from any other department of engineering; but in a branch as modern as that of electrical engineering the preliminary training ought to be specially thorough, because the many precedents and large accumulated experience of the past which can be drawn upon in other departments of engineering are not at the elbow of the electrical engineer. Prof. Owens makes a distinction between various classes of electrical engineers, basing his differentiation on the varied character of the work of the designing and the constructing engineer, and suggests the arrangement of the courses of study with a view to affording each of these classes the best course of training. Prof. Jackson has done well to call special attention to the necessity of stimulating and fostering the exercise of the student's judgment, and more particularly his common sense; and this reminds us forcibly of the saying of a celebrated engineer that every engineering formula ought to have a coefficient, "K," standing for common sense. We are not quite prepared to agree with those who take the stand that electrical engineering is nine-tenths mechanical engineering, for although the work of the mechanical engineer enters, to a considerable extent, into some departments of the electrical engineer's work, it nevertheless does not occupy that ratio of importance which some of the adherents of this theory would seem to attach to it. The subject is one which is worthy of the most serious consideration and may well engross the attention of all engineers.

THE STANDARD CENTRAL STATION.

If the electrical census which is now being prosecuted with vigor under the superintendence of Mr. Allen R. Foote accomplishes no other object it will have earned its right to the thankful recognition of the electrical community by pointing out many examples of how not to do things, and more particularly how not to build and operate an electric light and power station. It is fortunate that Mr. Foote has called to his assistance so intelligent an investigator as Mr. Horatio A. Foster, who, in his paper read before the American Institute of Electrical Engineers, at Chicago, showed how many stations were, from their very inception, handicapped by bad engineering and worse management. To expect a profitable business under such conditions would, of course, be asking too much, and hence the reason why not a few electrical enterprises have turned out unsatisfactorily. On the other hand Mr. Foster showed how a well-designed station, operated by competent men, is a source of more than average profit. The remedy which he suggests for mitigating the existing evil is the employment initially of a competent electrical engineer. He deprecates in no unmistakable terms the usual method of installing a plant by paying visits to certain prominent electric light stations, without other guidance than possibly that of the representatives of the selling companies themselves, and the choosing of a plan of construction from among a mass of undigested information gathered on such trips. While Mr. Foster's suggestion that the Institute, in connection with the National Electric Light Association, should lay down a set of rules and plans for a standard electric light station is one well worthy of consideration, the question seems pertinent whether the art has yet arrived at such a permanent state as to make such a step desirable at this time. The opinions of many competent men are still so at variance that it would appear problematical whether plans could be adopted, which would meet the views of even a majority of the electrical engineers of to-day.

ALTERNATE CURRENT LONG-DISTANCE TRANSMISSION.

The Chicago meeting of the Institute, besides its just claims as one of the most successful, thus far, in the career of that body, may also lay claim to having been the first to bring out a paper describing the practical operation of a long-distance alternate current transmission plant run "for business." We have heard and read so much about what *could* be done with the alternating current that it is doubly refreshing to learn what has actually *been* done. Mr. C. F. Scott's paper describing the Telluride plant is therefore of more than ordinary interest. He rightly lays stress upon the fact that even with the comparatively low potential of four thousand volts a large field of operation is within the scope of practical long-distance transmission, which, of course will be largely enhanced when we are able to handle higher potential. While the plan described is unquestionably successful, it might be claimed by some that such an installation does not combine all the elements of a successful system for general distribution of power by alternating current. But even if such were the case, there is a sufficiently large sphere of usefulness for the system as it stands to make its exploiting profitable to those engaged in this work.

ELECTROLYTIC REFINING OF COPPER

The air of mystery that has for a long time surrounded the processes for the electrolytic refining of copper is, we are glad to note, being removed and in a manner which leaves no room for doubt that in the near future this industry will occupy a leading position in the electric arts. Prof. Badt points out in his Institute paper that the principles are well established, and with proper attention to details success in this field is assured. With the immense mineral resources of the United States, which have already made it the largest copper-producing country in the world, it is not difficult to foresee the time when we shall supply foreign markets with electrolytically refined copper. That this can be done profitably is evidenced by recent shipments of such copper abroad, so that the producer is not entirely dependent upon home markets for the disposal of his product.

The meeting of the American Institute of Electrical Engineers in Chicago, last week, was a most decided success, and that which made it so was the heartiness of the welcome given it by Western members and friends. An excellent programme of papers was discussed and enough work went over to start the fall season with an afternoon and evening session.

SERIES ELECTRIC TRACTION.[1]

BY NELSON W. PERRY, E. M.

In railway practice, it is the distance rather than the quantity of current that forms the most important factor of increase, though the latter cannot be neglected in planning for the future. In street railway construction, assuming the distance to remain the same but the traffic to double, the amount of copper required to maintain the same relative economy must also be doubled. This is a minor matter as compared with the case where both distance and traffic are doubled. In this latter case, to maintain the same economy the weight of copper must not only be doubled but squared. The limit of extension even on these lines is, however, soon reached, and the only recourse, by existing methods, is to erect at or near the further point another generating station, with all that that implies in the way of additional investment in real estate, machinery, etc., and a duplicate set of employees.

In long lines, the bugbear of the multiple arc system of distribution is the drop in potential at the further end. There are two remedies for this drop in potential at hand—either to increase the amount of copper in the feeders, which within commercial limits is but a partial remedy, or to increase the pressure, using the same amount of copper which, when the multiple arc method of distribution is employed, introduces as many difficulties as it obviates. There is still a third remedy, and that is, to employ the constant current method, in which, under all circumstances, the current remains the same and the pressure varies as the work performed.

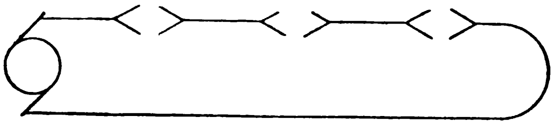

FIG. 1.

In the one case the copper must vary as the demands and distances—the pressure remaining the same, and in the other the pressure varies, the copper and current remaining the same.

If energy can be so much more advantageously distributed to long distances by the constant current method for arc lamps, why should this method not commend itself to the ever-increasing distances to which our electric street railroads are reaching? If the steam locomotive is ever to be supplanted by the electric motor, why should not this method of distribution be the one to be adopted? The answer is that the constant current method, as heretofore developed has not been sufficiently elastic to meet the requirements, and although the generation of a constant current involved much less complex machinery, and the cost of distribution to distant points necessitated a much smaller initial outlay, still the difficulties introduced by this method largely outweighed all its advantages.

It is my purpose to show how the constant current system may be made as elastic in every way, at least on paper, as the constant potential, without sacrificing in any way any of the advantages peculiar to the system, and how it is possible to make each unit in such a system nearly, if not quite, as independent of every other unit as is the case in the system now in vogue.

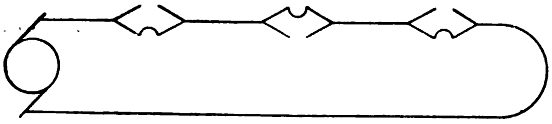

FIG. 2.

The system which I am about to explain may properly be described as consisting of a circuit interrupted by a series of breaks in multiples of two. Or one consisting of a circuit interrupted by breaks in multiple series with each other—the breaks being in multiples of two. The conception then would be like Fig. 1. But in order that a current shall pass around this circuit, it is necessary that *one* of the breaks in each multiple shall be normally closed. It matters not which one is closed, so our plan would now look like Fig. 2.

If a translating device should successively occupy each of these breaks, it would receive current during the time that its terminals connected the ends of the two broken wires, in proportion to the relative conductivity of the two paths open to the current. But we are not satisfied to have a portion only of the current pass through our motor—it is necessary that *all* the current must so pass. We must, therefore, make the resistance of the other branch infinite during the time in which the motor is bridging, through its terminals, the break, or, in other words, the normally closed branch must be broken.

If, therefore, we place an electromagnet in *series* with the normally broken branch, so that when vitalized it will open the switch in the normally closed branch, and allow it to close again by gravity or otherwise, when the magnet is devitalized, we have provided in a crude way for operating traveling translating devices in series. Our conception now would be represented somewhat by Fig. 3.

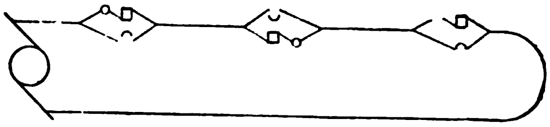

FIG. 3.

By this arrangement, the moving device only receives a momentary impulse as its terminals touch the ends of the break, and would have to rely upon its acquired momentum to carry it to the ends of the next break. It will be apparent, however, that it is immaterial whether the device receives its next impulse by closing the next break in the circuit or whether it skips that one and gets it from any other break, either on that circuit or from one connected with an entirely different dynamo. It is this feature that permits the use in my system of sidings on single-track roads, and of forks (the skipping of one or more breaks), and the intercommunication between separate circuits (the jumping from a break on one circuit to a break on another).

It is desirable, however, that the moving device be impelled by as nearly a continuous force as possible, instead of by a succession of momentary impulses. Instead, therefore, of having the ends of the normally open break face each other, as represented heretofore, we may extend these wires for some distance parallel with each other, and our plan assumes the form shown in Fig. 4.

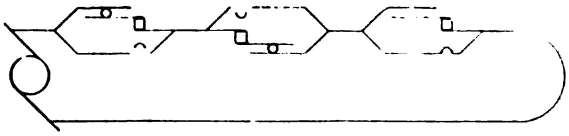

FIG. 4.

It is also desirable that the interval of time during which the device is without current, viz., that occupied in passing from one break to the next, shall be as small as possible. This naturally suggests having the normally open breaks all on the same side of the normally closed breaks, and if these parallel wires be continued so as to overlap those constituting preceding and succeeding breaks, a car or other moving translating device may pass from one break to another without even momentary interruption of current. In Fig. 5, the lower line which I call the "feeder," contains all of the normally closed breaks, represented by mercury cups normally connected electrically by a fork taking into them, which constitutes a double-pole switch actuated by an electromagnet in the manner to be described.

The upper pairs of wires, which it will be seen are merely the parallel extensions of the other possible path for the current, are in multiple with the path through the mercury cups. One of each of these pairs of wires, which will hereafter be denominated sections, is connected to the feeder wire on one side of the mercury cups, and the other has a similar connection on the other side. The two wires of each section normally without electrical connection with each other, constitute what has been termed the "series of breaks normally open." If, however, these two wires be connected electrically through the terminals of a motor, the latter will be in multiple with the mercury cups and momentarily receive only the current due to the relative conductivity of the path thus offered. By the arrangement shown in Fig. 5 the electromagnet which opens the mercury cup switch is in series with

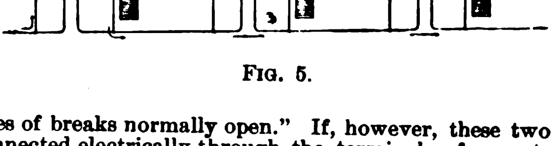

FIG. 5.

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[1] Abstract of a paper read at the general meeting of the American Institute of Electrical Engineers, Chicago, June 8, 1892.

the motor circuit, and the latter no sooner receives current than the former is actuated, the switch is opened and the whole of the current which was momentarily divided between the two branches, is diverted to the motor.

If the corresponding wires of the succeeding sections be caused to overlap without making electrical connection with each other, and these laps be staggered, as shown, a means is provided whereby the motor prepares the succeeding section for occupancy before wholly passing out of the one it is about to leave and accomplishes this without interruption to the current. Figs. 6 and 7 show how this is done and the arrows show the paths taken by the current as the transition takes place. When the motor is in the position represented in Fig. 5, there is but one path for the current, viz., around the open switch in the feeder and through the electromagnet by which it is kept open, back again to the feeder.

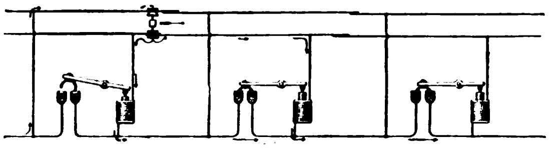


FIG. 6.

As the motor proceeds to the right, one of the terminals first embraces the lower lap, thus offering two paths for the current, one passing through the switching arrangement that controls the section the car is about to leave, and the other through that controlling the section it is about to enter (see Fig. 6). As it progresses still further this terminal passes beyond this lap at about the same time that the other terminal embraces the other lap. This leaves the first switch without current and the succeeding switch is automatically opened. There is no break in the circuit, however, even during the short interval occupied by the two switches in acting, for while the further terminal embraces the further lap, both of the switches concerned are short-circuited, as shown in Fig. 7. Before the further terminal has passed beyond the lapping portion of the two succeeding wires, the first switch will have closed and the succeeding switch will have been opened, thus diverting all of the current to the section upon which the motor has now entered.

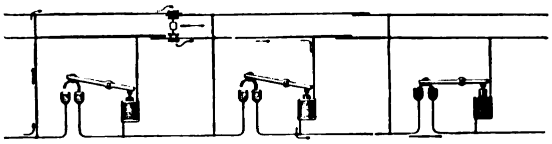


FIG. 7.

On single-track roads where turnouts are required, the turnout constitutes merely an additional section to one side of the main line, which is skipped by the car keeping the main track, and taken by the other car in passing. It, like every other section, has its own individual controlling switch, and when both the main track and siding are occupied by cars their motors are arranged in series with each other. We have thus provided a means by which a car may leave one section on a given road and enter another one on the same or another road without breaking the main circuit, *provided the car is always going in the same direction*. In all of the cuts thus far, the car is supposed to be going from left to right, and the switches are arranged accordingly; but, if we examine the drawings again, it will be found that in the plan suggested in Figs. 5, 6 and 7, if the car were going in the opposite direction, the circuit would be momentarily broken as it left one section and would fail to divert the current to the section it was entering. In a second plan the car is momentarily without current whenever it passes from one section to another.

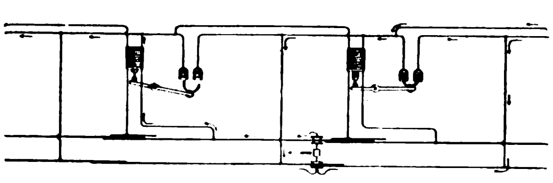


FIG. 8.

By combining these two plans, however, all of the difficulties seem to be removed. Figs. 8 and 9 show how this combination is effected, and the courses of the current when the motor terminals are in different positions on the wire. It will be noticed that, as in the first plan described, the trolley wires of adjacent sections are lapped, and that these laps are staggered; that parallel to, but insulated from, the nearer laps, is placed the subsidiary wire which short-circuits the switch to the right. The switch-controlling magnet, as is shown, has two coils wound cumulatively, and may be operated either by the current passing through the subsidiary wire, by that passing through the nearer trolley wire, or by both when it takes both paths.

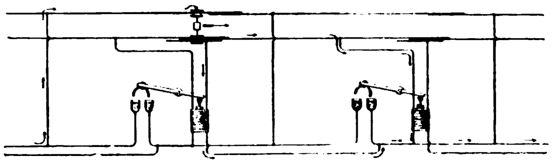


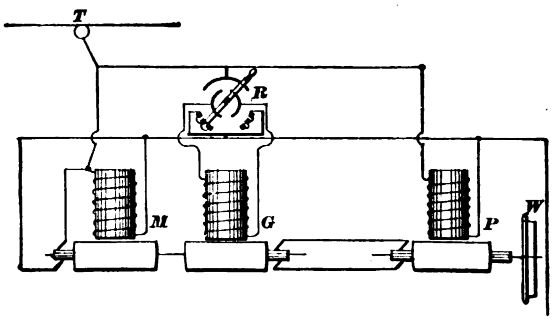
FIG. 9.

A NEW SYSTEM OF ELECTRIC PROPULSION.[1]

BY H. WARD LEONARD.

IF we could operate from the constant potential system a shunt-wound motor running at a constant speed and could interpose between this motor and the axle some device equivalent in its effect to an infinite number of different sets of mechanical gears, so that we could make use of any reduction desired, it would enable us while using a constant power to increase the torque as we decreased the speed, and *vice versa*, which is just what is desired in railway practice where the least torque is required when at full speed on the level, and the greatest torque is required at the slow speed in starting and in operating on a grade. Numerous and very ingenious devices have been invented for accomplishing this variable mechanical reduction, but on account of the complication, noise and unreliability they have never proved successful.

The writer has recently devised an electrical method of securing all the results which could be obtained from such a set of gears described, with a freedom from the noise, wear, complication and rigidity which such a set of gears would necessarily involve.



LEONARD SYSTEM OF ELECTRICAL PROPULSION.

T, trolley.
M, motor portion of power converter.
G, generator portion of power converter.
P, the propelling motor for the car.
R, the regulating and reversing rheostat in field of G.
E, the connection to ground.
W. the car wheel.

Following is a general description of the arrangement proposed, as indicated by the accompanying diagram.

Each axle is driven by a gearless motor, either directly or by means of a connecting-rod. The fields of these motors are excited directly from the constant E. M. F. of the line and independently of the armature circuit. Beneath the car and between the axles there is suspended a motor-generator, each armature winding being in a separate field. The motor portion of the motor-generator—which will, for convenience, be called the power converter—is shunt wound and connected just as a shunt motor is for use upon ordinary constant potential circuits. The field of the generator portion of the power converter has its field connected across the line and has inserted in it a regulating and reversing field rheostat. This field circuit is independent of the armature circuit. The generating armature of the power converter is in metallic connection with the armatures of the gearless propelling motors. It will be noticed that this circuit including the armature is a distinct and separate metallic circuit having no connection with the line in any way.

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[1] Abstract of a paper read June 8th, 1892, at the general meeting of the American Institute of Electrical Engineers in Chicago.

Suppose now that our shunt motor is running at full speed and that our controlling rheostat in the generator field circuit is at its central position, so that the generator field circuit is broken. Although the generator armature is being driven at full speed it is revolving in a field having no magnetism except the residual magnetism, and hence produces practically no volts. Let us now move our controlling switch so as to place the generator field across the line, but with a resistance in series with the field, of ten times the resistance of the field coils. We now get a slight excitation of the field and a development of volts at the brushes of perhaps 40 volts. This voltage will produce a current through the armatures of the driving motors dependent upon the ohmic resistance of this circuit only; and hence, even at this low voltage, a large current will be produced, which being in a field of full strength will cause a torque sufficient to start the armature. The speed of the armature will, of course, be governed by the counter E. M. F. which its revolution produces in its strong field; and hence, just as in the case of a shunt-wound motor, its speed will be practically constant so long as the E. M. F. supplied is constant.

If we now gradually increase the magnetic field of the generator by cutting out resistance by moving the controlling switch, we will gradually raise the E. M. F. of the armature circuit, and with it the speed of the driving motors. Since these armatures are revolving in a constant field, the torque they produce will be exactly proportional to the current in them, and the current will automatically flow exactly as is required to produce the necessary torque to maintain a speed such that the counter E. M. F. will approximately equal the E. M. F. supplied by the power converter. Thus it will be seen that the speed of the car will be dependent upon, and proportional to, the E. M. F. supplied by the power converter, and the torque or tractive effort will be dependent upon, and proportional to, the current supplied by the power converter

Let us suppose that 60 amperes flowing through the armatures in fully excited fields will produce a torque sufficient to move the load when upon a grade. It is evident from what we have seen that 40 volts from the power converter will produce this current. Hence, by an expenditure of 2,400 watts in the secondary circuit, or a total power, including field excitation, etc., of about eight h. p., we can start a fully loaded car upon a grade.

Under the existing systems, we would need the same 60 amperes in the same fully excited field, but would necessarily use the full voltage of 500 volts, and, therefore consume energy represented by 30,000 watts, as against possibly 6,000 in this system. The current from the line in starting the car under ordinary conditions by this system would be about 12 amperes at 500 volts, instead of from 60 to 100 amperes at 500 volts.

It will be evident from what has preceded that with this power converter system we can propel a car upon any practicable grade with a consumption of power no greater than is required to operate the car at full speed upon a level, by merely reducing the speed to the required extent. In street railways of from five to ten cars, this is of great importance, for it means that we can equip a road with about six h. p. per car, as regards the engines and dynamos, and that our conductors can be reduced to about one-third of the amount at present necessary, for we will never require more than 20 amperes at the distant point, where to-day we have to provide for 60 amperes with the same loss and same initial E. M. F.

Under the rheostat system the plant is severely taxed when an unusual crowd must be moved from a certain point, and it is then, when it is of the greatest importance that no break-down should occur, that it usually does occur. With this power converter system we could, upon a five-car road, start up and move with perfect safety 10 or even 20 cars from the most distant point on the road, though of course at a reduced speed, but the crowd would be handled with perfect success and without subjecting any portion of the plant to any unusual strain.

In the large cities it is no unusual sight to see an electric car moving at the slowest possible speed for perhaps several blocks. Perhaps 12 amperes are required to obtain the necessary torque. This at 500 volts is 6,000 watts. The power required for this slow motion by the proposed system would not exceed one-fifth of this amount.

Following is a tabulated statement (Table I) showing the results we may expect to obtain by this system in operating with fully loaded car under three different conditions: First, at 12 miles per hour on level; second, at three miles per hour on five per cent. grade; and third, at one mile per hour on level.

LEONARD SYSTEM OF ELECTRICAL PROPULSION.

TABLE I.

Duty of Car. Showing various losses expressed in watts.

Various losses involved.	8 tons at 12 miles per hour on level.			8 tons at 3 miles (or 5 tons at 5 miles) per hour on 5 per cent. grade.			8 tons at 1¼ miles per hour on level.		
	Full speed, ⅙ full torque; armature current, 10 amperes.			¼ full speed, full torque; armature current, 60 amperes.			⅒ full speed, ⅙ full torque; armature current, 10 amperes.		
	Power converter.		Driving motors.	Power converter.		Driving motors.	Power converter.		Driving motors.
	Mot'r part	Gen. part.		Mot'r part.	Gen. part.		Mot'r part.	Gen. part.	
Field	250	275	250	250	60	250	250	25	250
C^2R in armature	160	60	60	250	2,000	2,000	20	60	60
Friction	60	60	120	60	60	30	60	30	10
Foucault currents, hysteresis, etc	200	400	400	200	50	50	200	10	10
Total	670	795	830	760	2,170	2,330	530	125	330
Total watts wasted	.....	2,295	....	......	5,260	.....	......	985	.....
Watts of work done	......	4,000	....	......	6,000	.....	......	400	.....
Total watts absorbed	......	6,295	....	......	11,260	...	......	1,385	.....
Amperes at 500 volts	......	12.6	....	......	22.5	.....	......	2.8	.....

In arriving at the losses, as indicated, the motor part of the power converter has been assumed as having the following features: E. M. F. 500 volts, current capacity for 10 hours continuous duty, 15 amperes; resistance of shunt field winding, 1,000 ohms, armature resistance, 1.1 ohm.

The generator portion of the power converter and the driving motor are assumed as having the following features: E. M. F. 500 volts; current capacity for 10 hours' continuous duty, 40 amperes; resistance of field 900 ohms; armature resistance, 0.55 ohm.

The rolling friction with gearless motors on good level track is assumed as 20 lbs. per ton. Car is assumed to be eight tons in weight fully loaded and five tons for moderate load.

We find that with 12 tons moving at 12 miles per hour on a level we will require 12.6 amperes which is practically the same as by present series motor systems. With eight tons moving at three miles per hour upon a five per cent. grade 22.5 amperes will be required, which is about one-third of the power required by present systems. With eight tons at one mile per hour on level 2.8 amperes will be required, which is about one-fifth of by present systems. With five tons moving at five miles per hour on five per cent. grade 18.5 amperes will be required, which is about 40 per cent. of the power required by present systems.

The author then showed the various advantages accruing from the use of the proposed system, basing his figures on the statements and results obtained by various writers and experimenters on electric railways, and which are tabulated in Table III.

The comparative first cost of a railway of moderate size, say, from five to ten cars equipped by present systems, and by the proposed system, giving the detailed figures per car are given in Table II.

TABLE II.

Showing probable comparative first cost per car by present and proposed system.

	Present system,	Proposed system.
Steam plant, generators and conductors per car (steam plant 1,000; generators, 700; conductors, 500)	2,200	1,100
Motors (two 15 h. p. equipments)	1,800	1,400
Power converter	0	900
Controlling switches, cables, rheostats, etc	200	30
Total first cost per car	4,200	3,430
Saving in favor of proposed system per car		$770

Table III gives a summary showing the features of the proposed system as compared with the corresponding features of the present system.

TABLE [illegible]II.

	Present system.	Proposed system.
First cost of steam plant, generators, conductors and car equipment per car.....	$4,200	$3,430
Amperes at 500 volts required to start full load on level....	75	2.8
Amperes at 500 volts for full load at full speed on level. .	12.5	12.5
Amperes at 500 volts to start full load on 5 per cent. grade..	125	10
Amperes at 500 volts for working speed on 5 per cent. grade	60	22.5
Amperes fed back to system in coming down 5 per cent. grade..............................	0	10
Pounds of coal per car per hour.........................	50	25

The features of the proposed system which seem, at first sight, to be very objectionable are: The increased cost of the car equipment and the fact that we are adding an additional machine, having two fields, two armatures and three bearings; but, as we have seen, there is only an apparent increase in the first cost, for the saving in the generators and distributing plant far exceeds the additional cost of the car equipment; and the use of the motor-generator for elevators, traveling cranes, etc., has demonstrated that, as regards the attention it requires and the depreciation it suffers, it has a marked advantage over the rheostat or commutated field used in the present methods of operation.

NINTH GENERAL MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, CHICAGO, JUNE 6, 7 AND 8, 1892.

THE ninth general meeting of the Institute began in Chicago on June 6, at 10:30 a. m., at the Grand Pacific Hotel. The proceedings were opened by President Sprague, who called Mr. T. D. Lockwood to the chair.

The first business taken up was the reading by Mr. Carl Hering of a paper by Dr. Louis Duncan, of Johns Hopkins University, entitled "Some Experiments on Alternating Currents." Dr. Nichols remarked that the paper showed how much progress had been made in this work. A short time ago it would have been thought extremely good work to get such readings of the E. M. F. and current curves in, say, an hour, but here they had been taken in five minutes, and thus their simultaneity prevented any possibility of change in the conditions. Prof. Carhart told of some similar work he had done recently.

The next paper was one by Prof. H. S. Carhart, of the University of Michigan, on "The Relation between the E. M. F. of a Standard Clark Cell and the Density of the Zinc Sulphate Solution." It has been known for a long time, said Prof. Carhart, that the E. M. F. of a Daniell cell decreases with increase of the density of the zinc sulphate solution. The same is true of a standard Clark cell. When the solution is saturated at a higher temperature than the one at which the cell is to be used, the zinc sulphate crystallizes out as the temperature falls and again goes into solution when the temperature rises. As the increase of density causes a decrease in E. M. F., changes of temperature are accompanied by variations in the E. M. F., due only indirectly to the temperature changes. These variations have been included in the temperature coefficient. His own cells, remarked Prof. Carhart, are made with a solution saturated at a temperature lower than any at which the cell will be used. Hence the density does not change by this crystallization process and the temperature coefficient is reduced to half its former value. To ascertain the effect of changing the density of the zinc sulphate through a wide range, two of his students, Messrs. Cheney and Barnum, have made cells with solutions ranging in density from 1.036 to 1.429 at 20° C., and have ascertained that the E. M. F. varies from 1.485 volts to 1.438 at 15°, or something over 3.2 per cwt.

Mr. E. G. Willyoung added a few words as to the great degree of accuracy maintained by the Clark cells prepared under the Carhart method.

The next paper was read by Charles E. Emery, Ph. D., the well-known engineering expert of New York, on "Rational and Empirical Formulæ Showing the Relation between the Magnetomotive Force (*H*) and the Resulting Magnetization (*B*)." In this very interesting paper, the theory that magnetization is the circulation of an etheric atmosphere was examined by the law of the flow of fluids, with the gratifying result that a rational fluid function was developed, corresponding very well with the observed *H.-B.* curves of magnetization, and which, moreover, showed decidedly phenomena equivalent to those of magnetic saturation. The observed results indicated a more intense action during the earlier stages of magnetization than was provided by the fluid function; but the writer showed that the theory of molecular magnets appeared quite sufficient to account for such intensified action. The work of Weber, Maxwell, and Ewing on the last-named theory was reviewed at some length, and as an additional feature, Dr. Emery showed strain curves derived from the compression of steel almost identical in appearance with *H.-B.* curves of magnetism. He then remarked that action at a distance requires etheric force, that the fluid function identifies the motion as translatory rather than vibratory, and that, therefore, he considered the fluid function the important one; and that the molecular magnets only intensified the initial action. The first part of the paper closed with a discussion of the effect on existing theories as to the nature of light and electricity in case magnetism be definitely identified with etheric flow or circulation. The second part of the paper was entirely practical, giving empirical formulæ applicable to the tables given by Thomson and to the results of experiments made more recently by Steinmetz. Elaborate tables on different bases and in different units will accompany the formulæ in the printed paper. The paper was very well received, and many regrets were expressed that it had not been received in time to allow of its discussion in printed form.

The last paper read at the morning session was presented by Prof. E. L. Nichols for PROF. Geo. S. Moler, of Cornell University, on "A Dynamo Indicator or Instantaneous Curve-Writing Voltmeter." This instrument is intended to be used in tracing those curves which show the changes in potential of the two ends of a single coil of the armature, and also those showing the changes between one brush and one of the commutator bars, as the armature revolves. It consists in the main of a very rapidly vibrating needle of a voltmeter and a smoked cylinder against which the pointer is made to press at the required moment. The curve is traced during a single revolution of the armature, and is then easily transferred to paper. The voltmeter which is enclosed in the body of the little instrument is of the permanent magnet type. This paper elicited compliments to Prof. Moler, the main criticism being that of Prof. Crocker, who objected to the small range of amplitude of the curves shown, but means for enlarging the range were suggested by Profs. Nichols and Roberts and Dr. Emery.

The morning session was then adjourned.

The afternoon session of Monday was devoted to a visit to the Pullman Works, a special train having been provided by the Illinois Central R. R. Co. A large number of members went on this trip.

In the evening the meeting was held at the Chicago Electric Club, which has recently moved into new quarters and seized this opportunity of welcoming the Institute. The handsome parlors of the club were filled to overflowing. President B. E. Sunny, of the Chicago Club made a most cordial and felicitous address of welcome, and then introduced President Sprague, who read as his inaugural address to the Institute a paper on "Coming Developments in Electric Railways. It was a masterly exposition of the difficulties and problems incident to the heavier work now opening up before the electrical engineer, and won universal encomiums by its conservative though hopeful statement of the case. It is printed elsewhere in this issue. The paper was followed by a brief discussion, in which Ex-Mayor Cregier, Dr. Emery and Mr. T. D. Lockwood participated. A lunch was then served.

The Tuesday morning session was begun with President Sprague in the chair, and was continued under the chairmanship of Mr. Carl Hering. The first paper presented was one on "The Magnetic Permeability of Special Irons for Electrical Purposes," by Messrs. M. L. Thompson, P. H. Knight and G. W. Bacon of Cornell University. A number of curves, which went to prove the desirability of steel castings, were shown with this paper, which elicited a discussion from Messrs. Carhart, Nichols, Emery, Bradley and Jackson. The last named said it was matter of regret that these interesting tests had not been accompanied by chemical analyses, showing the effects of the varying proportions of carbon and manganese, or even from the introduction of aluminum.

A short paper was then presented by Prof. B. F. Thomas of the Ohio State University, entitled, "Notes on Wiping Contact Methods for Current and Potential Measurement." It was an interesting little sketch of work done as far back as July, 1880, at Stevens Institute on a Brush arc machine, with a tangent galvanometer for the current measurement and a condenser and Thomson galvanometer for the potential. In 1885 Prof. Thomas used the method again on a Thomson-Houston arc machine, substituting a Thomson portable electrometer with Leyden jars to increase its capacity, for the condenser and galvanometer, preferring them to all other instruments for high-potential curves.

In the discussion, Mr. Scott referred to the use of the telephone on alternating machines. The telephone was so delicate that it gave what was not wanted as well as what was wanted, but it was easy to tell the click peculiar to the contact.

Prof. Thomas then read another paper on "A Life and Efficiency Test of Incandescent Lamps," based on work done under his direction by Messrs. P. Martin and R. H. Hassler of the Ohio State University. These tests were made with 10 lamps of the ordinary 16 c. p. 110 volt type, of the A. B. C., Beacon, Columbia, Economic, Packard, Pennsylvania, Standard, Thomson-Houston, Edison, Perkins, Sawyer-Man and Steuben makes. The results were embodied in a series of curves, which. however did not take into account the question of price. The lamps in these curves were designated by letters. A number of facts were apparently brought out. For instance, one of the curves showed that the lamps on the average grew dim at a steady rate, falling off 90 per cent. in about 200 hours, to 68 per cent. in 600 hours, ending at a little less than 55 per cent. at 1,200 hours. Another plate of curves of all the lamps, showed an average initial value of 4.2 watts per candle rising to 5 at 300 hours, 5.9 at 600, 6.8 at 900 and 7 at the end. As to the time when lamps became "dead," if the time of decease were set at 50 per cent. of initial c. p., the lamps tested passed 1,000 hours on the average and certain makes ran up to 1,200. With the limit at 75 per cent., on the average all died at 450 hours. Prof. Thomas added that for the consumer to-day, the average lamp lasted at its fair value for about 230 hours, when they were past their prime. He added that one very remarkable feature brought out by the tests was the unquestionable freedom from blackening shown by lamps exhausted mechanically as compared with those exhausted on the familiar mercury pumps. Several such lamps were shown. Mr. J. W. Howell attackedthe paper very vigorously on various grounds. He pointed out that, strange to say, no 3-watt lamps had been included, and he regarded as utterly fallacious any tests based on 10 lamps of a make. Only a series of tests running through thousands of lamps would give a fair result for any manufacturer. As for some long-life lamps, he mentioned a case where he found an eternal lamp running on a 98-volt circuit. On taking it from its proud possessor be found it marked 108 volts. Mr. E. P. Roberts backed up Mr. Howell's criticisms to some extent.

A paper by Mr. H. A. Foster on "Some Points for Electrical Engineers" was then read by Mr. T. C. Martin, who pointed out that although 100 central stations, nearly all in a single State, had been visited by the writer. not a single mention had been made as to storage battery work by any of them. This contrasted strongly with the large use of storage batteries in European central stations. Mr. H. Ward Leonard also made some pithy remarks as to the gross mistakes made in central station design and location, and the economic value of the electrical engineer in this field of work.

The afternoon session of Tuesday, with President Sprague in the chair, was largely occupied by three very important papers on electric mining: "Electric Coal Mining Machinery," by Mr. Elmer A. Sperry; "The Electric Percussion Drill in Theory and Practice," by Mr. Henry R. Marvin; and "Long-Distance Transmission for Lighting and Power," by Mr. C. F. Scott. The first paper was an admirable discussion of the various features of bituminous coal mining in the West, and of Mr. Sperry's electric mining machinery designed to meet the special conditions. The amount of work done by Mr. Sperry was a surprise to almost everybody, while his ingenuity well deserved the praise bestowed on it by President Sprague. Mr. Marvin next pointed out the severe requirements imposed on electric percussion drills, and held that the solenoid and plunger afforded the simplest solution of the problem—his own methods being fully described. Mr. Scott's paper, to be found elsewhere in this issue, was an interesting description of the work done at Telluride, Col., with a Westinghouse alternating synchronous plant.

The session was brought to a close with the reading of the paper on "Railway Train Lighting," by Mr. A. H. Bauer, electrical engineer of the Pullman Company. This paper was printed in The Electrical Engineer last week.

The evening session was held at the rooms of the Chicago Electric Club. President Sprague in the chair. Mr. F. Upton and Mr. T. C. Martin, of the special committee on an improved method of electing officers of the Institute, filed a report embodying a system of letter ballot. It was referred to the next general meeting, accompanied by an informal vote of approval. A paper was then read by Prof. R. B. Owens, of the University of Nebraska on "Electro-Technical Education," and another was read by Prof. D. C. Jackson, of the University of Wisconsin, on "The Technical Education of the Electrical Engineer." Both were heard with closest attention by a large audience, and were freely discussed by Prof. Crocker, Messrs. Sprague, Sperry, Bradley, Lockwood, Emery, Upton, Perry and others.

A paper was then read by Mr. C. E. Carpenter, of St. Paul, on "A New Form of Resistance." This resistance takes the shape of very fine wire laid on an iron sheet and held irremovably thereto by a coating of enamel. The capacity of current reception and of radiating surface combined is enormous. Mr. Carpenter showed the special advantages of this compact device for stationary motor rheostats, street cars, stage regulators, etc., and exhibited some forms. He also shows the adaptation of the same idea to heaters, flatirons, small kettles, etc., and passed current through a number of them to illustrate their quickness and usefulness.

The morning session on Wednesday, was called to order by President Sprague, and Mr. T D. Lockwood then read his able and exhaustive paper on "Selective or Individual Signals," printed in the last issue of The Electrical Engineer.

This was followed by a batch of three papers on electric railway work: "Electric Railway and Motor Tests," by Prof. G. D. Shepardson and Mr. E. P. Burch, of the University of Minnesota; "Series Electric Traction," by Mr. Nelson W. Perry. and "A New Form of Electric Propulsion," by Mr. H. Ward Leonard. The paper by Prof. Shepardson detailed some tests of railway motors but its chief value lay in the curves which went to contradict the commonly accepted notion as to the straightness of the load line, as they showed tremendous fluctuations in the space of two or three minutes with a load of from 1,000 to 1,500 amperes. Mr Perry's paper rehearsed the experience with the Short series system, now abandoned, and argued that it was still possible and desirable to use a constant current method, of a nature very ingeniously worked out by Mr. Perry himself, with consequent saving in copper, etc. Mr. Leonard's paper dealt with a most ingenious and striking plan for utilizing a motor generator on the car, as the result of which the speed of the car would be dependent upon and proportional to the E. M. F. supplied by the power generator, and the torque or tractive effort will be dependant upon and proportional to the current supplied by the power converter. As a consequent result also from this method, for example, the current required from the line in starting the car would be about 12 amperes at 500 volts instead of from 60 to 100 amperes at 500 volts. Mr. Leonard argued that in his plan the increase in cost of equipment was more apparent than real, while the saving in current and the reduction of extreme loads was very considerably on the side of economy.

All three papers attracted attention, and the discussion excited was so active that it was deemed best to postpone it until the fall, when it will be taken up at an early meeting. Dr. Emery, Prof. Thomas, Messrs. Sprague and Leonard, all took part. Mr. Sprague having called Mr. H. L. Webb to the chair, addressed himself to a very animated discussion of the points involved, doubting the accuracy of some of the Shepardson figures, altogether discrediting the series system as a "back number" or "lost cause," and expressing a belief that Mr. Leonard's method when tried would be found wanting. Mr. Leonard replied and the discussion was then adjourned.

Dr. James B. Williams, of New York, then read a very interesting paper on "Oil versus Air as Insulation," in which he reported a number of experiments going to upset entirely the idea as to the higher insulating qualities of oil—so far as they went. The paper was not presented in print, and its discussion was therefore adjourned until the fall, when Dr. Williams will repeat his experiments before the Institute not only with air and oils but with a number of the leading insulations now known to commerce.

The facts set forth in this paper were obtained wholly from experiments and tests made by the doctor in New York City and by himself and his brother R. W. Welty in California while they were making the investigation of insulating material and its uses which is now being described in a serial in this journal. These experiments and tests were made with special apparatus designed and made by Dr. Williams for testing insulating material by means of charges of high potential; and the results obtained are worthy of careful consideration on account of the perfection of this apparatus. The potential of the charges used was about 2,300 volts. The results show that, when used to insulate conductors carrying high tension *constant* currents: 1. Air even with a humidity of 80 per cent. is far superior to oil. 2. That air is superior to pure paraffine. 3. That steam will conduct such currents, but is superior to oil. 4. A film of oil on glass and porcelain will not prevent surface leakage. 5. Oil, if placed on paraffined hard rubber, at once ruins the surface insulation of that material. Other subjects treated of were: 1. The expansion of oil in pipes or tubes. 2. The use of fibrous material in combination with oil. 4. Absorption of moisture by oil.

Reference was also made to some new forms of insulated conductors invented and patented by the doctor, in which dry air in combination with other insulating material is used to form the dielectrics thereof.

The meeting then adjourned.

On Wednesday afternoon through the thoughtfulness of the local committee, and the energy of Mr. F. De Land, the members and a large number of friends, making a party of about 100 were enabled to pay a special visit to the World's Fair Grounds and view the work now going on there. The Illinois Central Railroad provided a special train, and at the grounds another special observation train was found ready, with escorts. The party was accompanied by a large number of ladies, and was also favored with the guidance of Prof. Barrett, commissioner, and Dr. Allan V. Hornsby, secretary of the Electrical Department. Nearly all the buildings were inspected, and three cheers were given for the huge Electricity Building, now about half finished. The party were also given an opportunity of seeing, in the Forestry Building, several of the pieces of statuary that are to adorn the various edifices. The tour of inspection occupied fully two hours, and not a single visitor came away without a feeling of pride and admiration regarding the scope of the work, the magnificence of the design, and the manner in which the whole plan is being carried out. The electrical engineer who does not visit Chicago in 1893 will have occasion to regret it.

The thanks of the members were specially due to the local committee comprising Messrs. E. M. Barton, chairman, C. A. Brown, W. A. Kreidler, Chas. Wirt, and Dr. Elisha Gray; also to the Chicago Electric Club, which kept open house for all the visitors during their stay. Among the invitations received and accepted were those from the Pullman and Western Electric Companies, the Love conduit electric railway system, and the Sperry Electric Mining Co. Messrs. Brown and Warner placed their sloop yacht at the disposal of members, several of whom were glad to get a view of Chicago from the lake. The Illinois Central R. R. Co. also did the handsome thing in providing the Institute with special railroad facilities, free of charge.

After the convention several of the members proceeded further West to Denver to take part in the gathering of Railway Telegraph Superintendents. Among those were Mr. T. J. Smith, of the E. S. Greeley & Co., accompanied by Mrs. Smith, Mr. and Mrs. T. D. Lockwood and son; Mr. S. S. Bogart, and Mr. R. W. Pope.

THE following is a list of those in attendance:

E. P. Burch, C. S. Bradley, E. M. Barton, C. A. Brown, M. J. Buckley, S. S. Bogart, J. F. Barclay, Prof. F. B Badt, P. P. Beals, Prof. H. S. Carhart, C. L. Cornell, G. Cutter, W. B. Cleveland, Prof. F. B. Crocker, W. A. Cothren, E. Caldwell, A. H. Cowles, J. F. Connor, W. F. Collins, C. H. Dunbar, F. De Land, Leo Daft, M. A. Edson, Dr. Chas E. Emery, S. D. Flood, C. R. Gilman, J. H. Gregg, Carl Hering, M. S. Howard, F. S. Hunting, A. L. Hadley, John W. Howell, R. S. Hill, C. C. Haskins, E. M. Hughland, Prof. D. C. Jackson, Capt. A. de Khotinsky, J. Kettlestrings, T. D. Lockwood, L. V. Lindon, H. Ward Leonard, H. N. Marvin, C. K. McFadden, F. P. Mills, T. C. Martin, E. A. Merrill, Percy Martin, J. W. McCrosky, R. J. Miller, Prof. E. L. Nichols, Prof. R. B. Owens, J. J. O'Connell, M. O'Dea, R. F. Outcault, A. F. Oppermann, R. W. Pope, G. M. Phelps, Frank C. Perkins, Nelson W. Perry, C. W. Parks, W. M. Porter, E. P. Roberts, Frank B. Rae, W. D. Ray, Prof. G. F. Shepardson, J. R. H. Staley, C. F. Scott, L. L. Summers, Frank J. Sprague, M. B. Speir, B. E. Sunny, A. Strate, W. N. Smith, E. A. Sperry, M J. Sullivan, E. F. Seixas, T. J. Smith, C. F. Street, C. M. Sames, Prof. B. F. Thomas, F. R. Upton, E. G. Willyoung, Herbert Laws Webb, Dr. J. B. Williams.

COMING DEVELOPMENT OF ELECTRIC RAILWAYS.[1]—I.

BY FRANK J. SPRAGUE.

IT is a trite but mistaken saying that electricity is in its infancy. It dropped its swaddling clothes when Morse sent the first telegraphic message. It put aside dresses and pinafores when the dynamo machine and arc light were invented. The incandescent lamp, the telephone, the art of welding, the transformer, are incidents of buoyant youth; the modern electric motor and electric railway mark a vigorous manhood.

The truly marvelous development of electric applications of every kind, the accomplishment of many things which in ignorance of the very art, or lack of knowledge of what are now well-known facts, and more particularly the great commercial development of the transmission of power, whether for stationary purposes or for electric railways, has led many to foolish prediction and idle boast.

This is no age of inspiration, nor time for hopes never to attain fruition. It is above all things a practical age, perhaps too practical, but nevertheless one in which commercial enterprises to be successful must promise either a new field of development or economies in older fields.

As the orthodox few have been waiting in sublime faith for many centuries, and will wait for many more for the fulfilment of ancient prophecies, so too will impracticable electric enthusiasts vainly wait for the millenium when investments are boundless, performances limitless and efficiencies unity.

It would perhaps have been proper in making my inaugural address to so representative a body as that of the American Institute of Electrical Engineers that I should touch upon the special discoveries and experiments which have recently attracted attention, but there have been so many enthusiastic and brilliant workers that neither the time at my disposal nor the knowledge I possess would permit me to do justice to their work; hence it seems better to take up a subject with which I have been more particularly identified, which to-day commands so much attention and concerning which there are such conflicting opinions. While finding encouragement in the past achievements of our profession, I think the time opportune for a word of caution.

Electric street railways are no longer experimental nor is their success problematical. Their history for the past five years is that of an almost unequaled development. Almost within a decade has occurred the first working of a practical electric railway. In a third of that period there have been put in operation, or are under contract, more than 450 roads, equipped with nearly 6,000 cars and over 10,000 motors, and with over 3,000 miles of track. There is made a daily mileage of not less than 700,000 miles, and over a billion of passengers are carried annually. At least $75,000,000 have been invested in this industry alone. Thirty thousand horses in a single year have been relieved from the slavery of street car propulsion; stables are disappearing and streets becoming cleaner; luxurious cars are running on smooth, well-built and rigid road-beds. Dividends have been increased, expenses reduced, investments enlarged; the unproductive has become productive, the impossible possible. Land values have been increased, habitable limits extended, homes created and time saved.

We no longer hear seriously of the dangers of the trolley wire, the failures of service. The time has come when legitimate investment is amply warranted. Electric street railway construction has become a matter of engineering, not experiment. Not only have the smaller towns adopted what is the only available means of current supply, but the larger cities are following their example. St. Louis and Baltimore, Minneapolis and St. Paul, Buffalo and Rochester, Boston and Brooklyn have fallen into line, and latterly even Philadelphia seeks an improved street service, and in New York public interest is being aroused.

The general feeling of opposition to poles and wires, ought not, however, to act as a barrier to such reasonable and proper introduction of an overhead system of supply, as the conditions now existing in that city very properly warrant. I have frequently pointed out the fact that the greatest good can come to the greatest number, especially in the over-burdened condition of transit which there exists, if certain of the lines were electrically equipped; wherever, in fact, there would be no street obstruction. On streets occupied with elevated structures, these structures themselves could be used for a practically rigid overhead system.

Among the numerous places in New York where an overhead system could be put in perfect operation are Central Park West, the Boulevard from Fifty-ninth street up, a part of the First and Second Avenue lines; the Third, Sixth and Ninth Avenue lines, and all the suburban extensions in the annexed district. I am not sufficiently familiar with the streets of Chicago, which is the last other remaining city which must consider electric street railways.

In these larger cities, however, one condition should be insisted upon, and if this condition is met in the proper spirit then much of the objection which has been raised against an overhead system must necessarily disappear.

The construction must be of the very best. The only overhead line allowed should be a contact wire with sufficient strength; the main conductors and the feeders should be put underground in proper conduits. There would then be overhead only a wire necessary for the smallest duty and of the requisite strength. In many streets, of course, the cable will hold its own until an electric conduit or surface contact system shall be proven satisfactory.

Impressed by the great development of this industry, and brought face to face with the changes it has wrought, the query is continually made—will the electric motor replace the steam locomotive? It is similar to the older questions, Will the telephone replace the telegraph? Will the electric light annihilate the gas system? And in all soberness a like answer can be made: "It will not; but it will, as the electric light and as the telephone have done, create a field of its own, and will replace a portion of the service now done by steam."

It seems to me that the growth of electric railways will proceed something in this order. First, the street systems in the various towns; then connecting lines between adjacent towns following the lines of highways; then longer connecting lines, either on the tracks of existing steam lines, or, growing bolder, on exclusive rights of way on the same order. Then will come suburban traffic on a larger scale, and freight transfer systems, and finally the more ambitious projects of trunk-line service under limiting conditions, such as I will specify.

It has been very properly said that a man will make the first long ride on electric railways by transferring from one town system to another through connecting links, rather than on individual roads. This is precisely the process by which great steam systems have been built up, although, of course, starting on a larger scale; and it is but natural that this shall be one step in the development of electric railways.

But evidently this natural process of evolution does not offer scope enough for the more enthusiastic, and we are now and again treated to an ideal electric road to be built on plans boldly defying both geography and the abodes of civilization.

An air line route according to rules of surveying allowed only in Russia and on the desert of Sahara; abolition of grades and street crossing; rigid and continuous rails; loaded cars of light weight, each operated by its own motor and making few or no stops; unlimited potentials and undiscovered resistance to insulation; new physiological and engineering laws; indestructible machinery; unheard-of powers of braking and new methods of train operation and signaling; around all, a clear atmosphere; above all, a perpetually smiling heaven, and behind all the unlimited bank account of the investor,—such are some of the characteristics of such a road. But perhaps it is but fair to ask, Given some of these conditions, what would be the capacity of steam traction?

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[1] Presidential address delivered at the Chicago meeting of the American Institute of Electrical Engineers, June 6, 1892.

Letters to the Editor.

THE INSULATION RESISTANCE OF INTERIOR CONDUITS.

If insulation is not a desirable factor in electric wiring then let iron or other metal pipes be employed. If, however, insulation is a good thing, I presume the electricians with brains will admit that you cannot have too much of it. In this connection permit me to call the attention of your readers to the subjoined report of Prof. Crocker, of Columbia College. It has been my aim to obtain the highest possible insulation consistent with economical manufacture. This report indicates the measure of my success. If, perchance, a more fanatical insulationist than I exists, I have no objections to his "seeing my ante" and "going me one better" by employing the best insulated wire the market affords and putting it in my tubes.

EDWD. H. JOHNSON.

NEW YORK CITY, June 9, 1892.

(Copy.)

ELECTRICAL ENGINEERING DEPARTMENT,
COLUMBIA COLLEGE,
NEW YORK, June 8, 1892.

MESSRS. THE INTERIOR CONDUIT AND INSULATION CO.,
42 Broad street, City.

Dear Sirs.—I have tested a sample of your regular form of tubing with the following results:

A ten-foot length of tubing has an insulation resistance of thirteen thousand two hundred and fifty (13,250) megohms at five thousand (5,000) volts electrical pressure. The insulation was tested between the brass tube or sheathing which usually surrounds your insulating tubing, and a brass pipe fitting tightly inside the insulating tube. I applied the 5,000 volts pressure a great many times for considerable periods of time, and also applied 5,500 volts pressure without the slightest lessening of the perfection of the insulation.

The voltage was obtained from a special continuous current dynamo. This is a more practical and probably a more severe test than using a static charge, which latter is the ordinary method of making high voltage tests of insulation.

I believe that the insulation would stand even a much higher voltage without breaking down.

Yours truly,
(Signed) FRANCIS B. CROCKER.

LEONARD'S NEW THREE-WIRE SYSTEM.

UNDER the title "A New Three-Wire System" there appears in your issue of June 8, 1892, a description of certain arrangements or devices which were worked out by Mr. E. W. Rice, Jr., and myself some time ago and practiced a considerable time ago.

Mr. Leonard in his article does not distinctly claim the new three-wire system, but he leaves it to be inferred that the system, is one of his own invention. I may be pardoned therefore, for calling his attention to the fact that what he shows in his Figs. 3, 4, 5 and 6, has been anticipated by us and combined with other improvements, such as transfer switches for transferring the compensating counter-electromotive force machines or apparatus from one side to the other of the three-wire system, at will.

The counterpart of Mr. Leonard's Fig. 3 in which the storage battery is used as a counter-electromotive force device on one side of a three-wire system is found in Fig. 6 of my patent No. 360,125, dated March 29, 1887, to which I refer Mr. Leonard for confirmation. The counterpart of Mr. Leonard's Fig. 4 is found in Fig. 1 of the patent to Mr. E. W, Rice, Jr., No. 460,364, dated Sept. 29, 1891, and the machine shown by Mr. Rice has the advantage over those shown by Mr. Leonard in that it is compounded for drop. The arrangement shown in Mr. Leonard's Fig. 5 has its counterpart in the joint patent to E. Thomson and E. W. Rice, Jr., No. 468,123, dated Feb. 2, 1892, with the improvement that the machines corresponding to B and C of Mr. Leonard's figure are combined in a motor-generator which is compounded for drop and requires therefore no hand regulation of field. Mr. Leonard's Fig. 6 is an extension of the same idea to a double three-wire system. Attention is also called to my patent No. 468,122, which in Fig. 1, shows an arrangement like that of Mr. Leonard's Fig. 4, except that the machines are compounded for drop and that automatic devices are employed to transfer the machine corresponding to C in Mr. Leonard's figure to the lightly loaded side on which the highest potential exists, so as to keep it a motor at all times.

An inspection of the documents mentioned will, I think, display the fact that the system set out by Mr. Leonard had been more fully worked out by ourselves, and while our systems may not have been in existence long enough to entitle them to be called "old," they are certainly not new in the sense in which they appear in Mr. Leonard's article.

ELIHU THOMSON.

LYNN, MASS.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED MAY 31, 1892.

Alarms and Signals:—

Contact-Post for Electric Bells, F. W. Manger and O. H. Huebel, 475,783. Filed Feb. 29, 1892.

Employs a bifurcated contact post fastened to the base plate.

Automatic Fire-Alarm System, C. Burgher, 475,925. Filed Jan. 29, 1892.

Conductors, Conduits and Insulators:—

Insulator-Pin, F. M. Locke, 476,207. Filed Jan. 30, 1892.

Claim: The combination with an insulator of a post having a vertical recess clear across the outer end and a layer of soft material interposed between the insulator and the post.

Electric Conductor, C. W. Bassett, 475,990. Filed Feb. 1, 1892.

Employs an insulation of seamless paper over which is placed a second protective cover.

Distribution:—

System of Electrical Distribution, C. O. Mailloux, 475,877. Filed Nov. 25, 1891.

Provides for the control and regulation of pressure at different parts of a system without loss of efficiency.

Dynamos and Motors:—

Dynamo-Electric Machine, W. Koedding, 476,151. Filed Jan. 31, 1891.

Has for its object a very low rate of speed and great initial force in all positions of the armature.

Galvanic and Thermo-Electric Batteries:—

Secondary Battery Electrode and Process of Making the Same, A. Reckenzaun, 475,797. Filed Sept. 13, 1890.

Has for its object the production of active material upon the surfaces of plates by means of the electric arc.

Lamps and Appurtenances:—

Incandescent Lamp, J. Ball, 476,183. Filed Nov. 23, 1891.

Relates to incandescent lamps having two filaments either of which is available for use as circumstances require.

Device for Testing Arc Light Circuits, A. H. Manwaren, 476,156. Filed Feb. 3, 1890.

A device for ascertaining while the lamps are burning how many are in operation, and also to detect and locate grounds on the circuit.

Electric Light Shade, H. A. Miner, 476,021. Filed Dec. 31, 1890.

Seal for Leading-In Wires, H. D. Burnett, 475,998. Filed March 7, 1892.

Employs a yielding support for the leading-in wire near the point where it enters the glass.

Railways and Appliances:—

Safety Attachment for Railway Trolleys, M. A. Yeakley, 476,028. Filed April 7, 1891.

Automatically draws down the trolley in case the latter accidentally leaves the wire.

Conduit for Electric Railways, W. F. Carr & C. F. Ferrin, 476,128. Filed August 6, 1891.

Employs removable arch blocks detachably secured together and held in position by lugs.

Hanger for Electric Railway Wires, C. B. Elliott, 476,192. Filed Nov. 30, 1891.

Employs a shell provided with a protecting cap and having an annular water shed protecting the insulating material in which the hanger is embedded.

Swivel Pull-Off for Overhead Wires, C. B. Elliott, 476,193. Filed Nov. 30, 1891.

Provides means for enabling the members of the supporting device to be adjusted with relation to each other.

Electric Railway Motor, J. F. Shawhan, 475,970. Filed May 10, 1890.

Claim 1 follows:

A combination with a car axle of a motor supported thereon, the said motor consisting essentially of two electromagnets and two armatures, the armatures being connected with the axle.

Railway Signal System, W. G. Wattson, 475,955. Filed June 17, 1891.

An electric block system.

Telegraphs:—

Telegraphy, T. Gothorpe, 475,988. Filed August 15, 1889.

Has for its object to produce a more equal variation of potential at the distant end of a line.

Telephones and Apparatus:—

Telephone, E. M. Harrison, 476,200. Filed August 9, 1890.

Employs an elliptical diaphragm having its edges free.

Telephone, S. F. Sherman, 476,026. Filed March 2, 1892.

Employs a variable resistance made of a piece of carbon creased or folded to form plaits.

Submarine Telephone, H. Finch, 476,207. Filed Oct. 23, 1891.

Claim 1 follows:

A telephone comprising an electromagnet embedded in a water-resisting compound.

Measurement:—

Electric Meter, O. Ericsson, 475,759. Filed July 23, 1891.

Employs a lever and pawl through which motion is transmitted, a cam to move the lever and another cam controlled by the measured current.

Miscellaneous:—

Electric Wire Holder, E. L. Lloyd, 475,781. Filed August 6, 1891.

Employs an engaging hook and loop clasped upon the insulator.

Telephonograph, J. P. Magenis, 476,054. Filed July 23, 1891.

Employs a phonographic cylinder in which the pressure of the stylus is augmented by magnetic attractions instead of gravity.

Wire-Gauge, C. J. Nifler, 476,057. Filed Dec. 29, 1891.

Consists of a cam-shaped plate and a pivoted arm having a notch near the outer end for the purpose of holding the wire to be gauged between it and the plate.

Electric Terminal, H. Sanche, 476,060. Filed Sept. 29, 1891.

Has for its object to provide a terminal with which the denuded portion of the wire may be readily connected and which will be held with complete protection to the cut end of the insulating covering.

Electrical Reciprocating Tool, W. P. Carstarphen, Jr., 476,225. Filed June 1, 1892.

Employs a reciprocating plunger moving within the tubular spools of two sets of coils through which a direct current is alternately passed.

Electric Self-Winding Clock, F. M. Schmidt, 475,809. Filed Oct. 9, 1892.

Coal-Cutting Machine, I. Wantling and J. T. Johnson, 475,833. Filed Nov 25, 1891.

A duplex rotary coal-cutter in which the two rotating cutters turn in opposite directions.

Rheostat, F. W. A. Schneider, 475,898. Filed July 20, 1891.

Consists of saponified fat in a suitable casing interposed in a circuit and fitted with terminals.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

You may knock under to the heat, but your "ad" is just as effective in hot weather as in cold.

THE "L. P. & D." SYSTEM OF DRIVING DYNAMOS.

Readers of The Electrical Engineer will remember short articles that have from time to time appeared in its pages in regard to the unique method of power transmission devised by Messrs. Perry & Demeritt, of Montpelier, Vt., and will be interested in a more detailed description of the system.

In the accompanying illustrations the diagram, Fig. 1, shows the position of the driving device and transmitting pulleys which may be changed to meet the requirements of any particular station, so long as the relative position of the driver, transmitting pulley and belt remains the same. It can be arranged to belt up or down and the direction of rotation may be reversed, although the better arrangement is as shown. This system can also be used when the smaller pulley is on the motor and the larger one is driven; but in any case the slack side of the belt which may be long or short as desired must clear the larger pulley.

It is plain that with this arrangement of belt and pulleys a dynamo or other machine may be stopped or started by moving in the proper direction either of the pulleys encircled by the belt. This gives a very flexible system. It can be used everywhere that a straight belt can, at the same time being claimed to give a greater driving power; but its best point is shown at close quarters where the other would not work at all.

In designing this transmitter, the aim was to produce a machine that would make the dynamo independent, and when the belt was at rest, to have the driving pulley and shaft free from contact with any part of the transmitter or belt. This desirable end has been attained, and the operation seems to compare very favorably with any other device for stopping and starting. Another idea was to use as few parts as possible and to embody in these the best mechanical principles in operation. The success of the transmitters shows the wisdom of this policy.

The following is related of the first machine installed: "When it (the machine) was set up and belted to a dynamo its friends were anxiously watching the operation of starting and stopping, which was very successful. As the wires for loading the dynamo were being arranged, the inventor explained that he expected to help out the belt wrap on the driving pulley by pressing the transmitter pulley against it. The machine was started up and 'pinch' applied. Circuit after circuit was thrown on until the capacity of the dynamo was reached, when they found they were getting fifteen per cent. more work out of an eight-inch belt than could be obtained in straight belting and the dynamo bearing ran cool. But the noise from the two pulleys pinching the belt was terrible; so as a further test the pinch was removed until the transmitting pulley ran quietly, when to the surprise of all the belt still carried the load steadily, showing no signs of slipping."

With the belt contact as shown in Fig. 1, or any similar arrangement of belt and pulleys giving a belt wrap four times the diameter of the driven pulley upon the driver, the belt will slip first upon the driven pulley; thus the driving power is calculated by the belt speed and contact on driven pulley. There is claimed for this device increased belt power with less friction on bearings than any other system, together with equally good control of dynamo; also that it is as easy to set up and as cheap to maintain as the best, while its economy of space is strikingly shown in the station plan, Fig. 2. Here are six 2,000 c. p. 50-light T. H. arc dynamos, with all shafting, pulleys, bearings and six "L. P. & D." power transmitters, installed on a floor space of 17 feet 2 inches, including two cut-off couplings. Each dynamo can be started or stopped independently of the others. The dynamos are two feet apart, giving ample room to operate each machine. When the dynamos are not running, the main line pulleys are entirely free from any contact whatever with dynamos or belting.

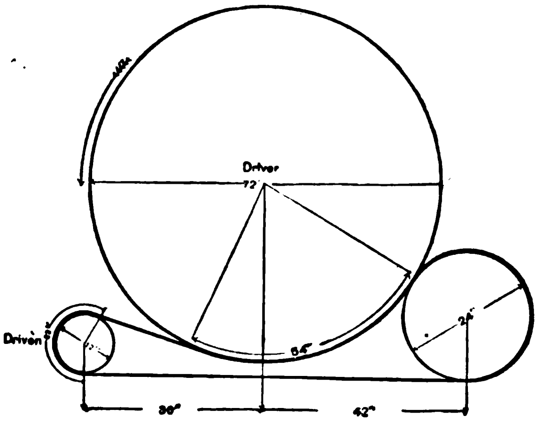


Fig. 1.

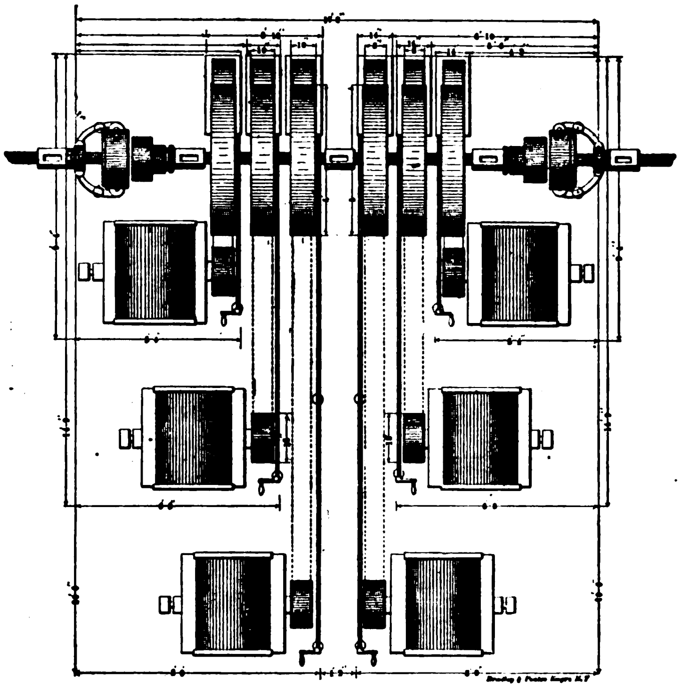


Fig. 2.

BALL ENGINE CO.

The Ball Engine Co., of Erie, Pa., report the following recent sales:

Santa Cruz Electric Light and Power Co., Santa Cruz, Cal., 200 h. p. tandem compound; Hotel St. Louis, Minnetonka, Minn., 60 h. p. simple engine; Risdon Iron Works, San Francisco, Cal., 200 h. p. cross-compound, two 200 h. p. tandem compound, 85 h. p. simple engine, 50 h. p. simple engine, 60 h. p. simple engine; Sandusky Electric Light Co., Sandusky, Ohio, two 130 h. p. simple engines, 100 h. p. simple engine; Portland Railway Co., Portland, Me., 250 h. p. simple engine; East Liverpool Western Electric Co., East Liverpool, Ohio, 200 h. p. simple engine; Hotel Stratford, Philadelphia, Pa., 50 h. p. simple engine; Cooley & Vater, Minneapolis, Minn., 60 h. p. simple engine; Electric Light Co., St. Peter, Minn., 100 h. p. tandem compound; Fremont Electric Light and Power Co., Fremont, Col., 80 h. p. simple engine and steam plant complete; Middlesex County Workhouse, Boston, Mass., 130 h. p. simple engine; Riverside Knitting Mills, Cohoes, N. Y., 35 h. p. simple engine; Johnson Company, Johnstown, Pa., two 300 h. p. simple engine, 200 h. p. simple engine, 100 h. p. simple engine; Jackson Gas Light Co., Jackson, Miss., 100 h. p. simple engine and steam plant complete.

RIES SOCKETS.

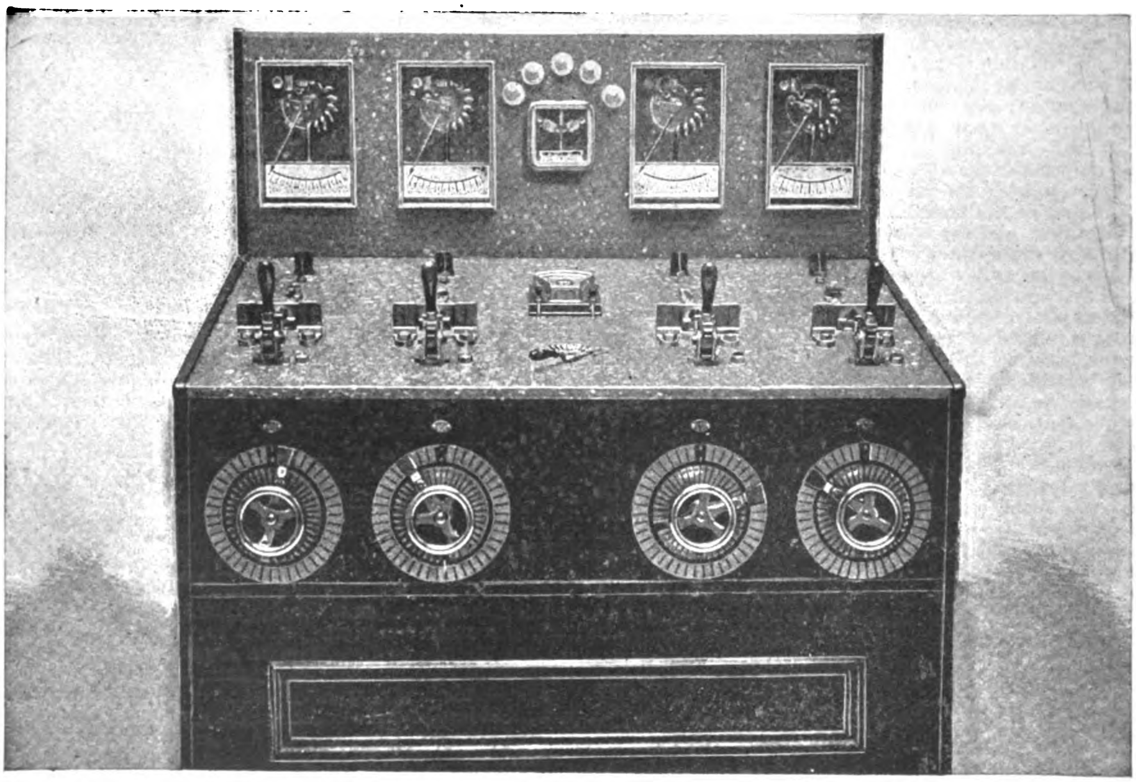
The Ries Electric Specialty Company, of Baltimore, are having such a large demand for the Ries regulating socket for alternating current incandescent lamps, that it has become necessary to increase facilities. In order to meet the demand it was decided at a recent meeting held by the company, to increase its capital stock to $150,000, which, we are informed, was all subscribed before the increased capitalization papers were issued. The company are now making their sockets for all standard lamps and for alternating current circuits of any voltage from 50 to 110. These sockets are also having a very large sale to manufacturers of alternating fan motors, who recommend them highly.

This company have delightful offices at the corner of Eutaw and Baltimore streets, Baltimore, Md., and cordially invite any visitors to their city to make their headquarters with them.

EDISON CONTROLLING TABLE FOR STREET RAILWAY STATIONS.

In the operation of electric railroads not the least point for consideration is that of facility and rapidity of control of the electric power generators. Until recently the large switchboard has been employed necessitating extreme agility on the part of the electrician in charge to bring the output of his generators to the desired point, and this plan has been found not only cumbersome, but expensive.

In order to secure a thorough, effective and rapid control of the generators in an electric railway station, a new device has been gotten up by the Edison General Electric Co. known as the railway controlling table, and shown in the accompanying illustration. On this are mounted all the regulating and indicating apparatus in the most compact and convenient space. The frame work is of strong bar iron. The lower part of the front of the table and the two ends are of sheet iron ornamented with a moulding in relief. The table top, upper part of the front and the upright back-piece are, in the table illustrated, of polished Tennessee marble, but this is an exceptionally fine piece of work; the more frequent custom is to have these pieces made of polished or plain slate. In front are the dynamo field regulators operated by wheel handles and duly numbered in reference to the machines they control. On the table are mounted the crossbar snap switches—new style switches recently designed—the dynamo fuse blocks and the equalizing bar switches, one of each for each dynamo; a voltmeter of the Weston type and a voltmeter switch of the regulation pattern.



Edison Controlling Table for Street Railway Stations.

On the upright back-piece are the amperemeters and the galvanometer. The amperemeters are of the standard Edison type, the solenoid of bar copper highly polished being mounted directly on the marble. The covers are of polished brass with moulded edges in which are set the beveled glass fronts.

The galvanometer shows when the voltage of the current of one of the generators about to be switched into circuit is the same as that from the other machines already supplying the circuit. It consists of two coils arranged one on either side of a pivoted indicating needle of soft iron. This needle is polarized, being pivoted within a piece of steel previously magnetized. If the voltage of the current from the generator ready to switch into the circuit is too high or too low, the deflection of the needle indicates the fact, so that the field regulator can be adjusted until the voltage is correct, when the needle presents no deflection. This instrument is mounted directly on the marble, its cover being similar in style to those of the amperemeters just mentioned.

With this controlling table in the station, the electrician has no difficulty in swiftly regulating his output of current to meet the varying conditions under which the road may be working. With one hand on the snap-switch handle and the other on the wheel of the field regulator an almost simultaneous movement is possible and control is thus immediate. The table shown was designed for four generators.

"THE STREET RAILWAY GAZETTE."

Our readers will be interested to learn that Mr. M. J. Sullivan, the editor of the *Street Railway Gazette*, of Chicago, has now become the proprietor of that journal, and will henceforth continue to conduct it as editor and publisher. We have before us the issue of May 30, which appears in a warm, old-rose cover. The number before us contains an interesting article on "The Future of Electrical Traction," by the sanguine Mr. Erastus Wiman and a variety of other matter, largely electrical, of interest to the street railway manager. The *Gazette*, besides containing each week the news of the street railway world, publishes a divided directory of American street railways showing the four hundred roads already operated by electricity and the four hundred roads laboring under the old system. Mr. Sullivan has our best wishes for his success.

THE ELECTRIC HEAT ALARM AND THE NEW ENGLAND INSURANCE EXCHANGE.

The Electric Heat Alarm Co., whose excellent little device for indicating the presence of hot bearings in all kinds of machinery was recently described in these columns, are justly proud and exultant over the endorsement of their apparatus by that conservative body, the New England Insurance Exchange, as shown in the following letter:

Boston, Mass., June 1, 1892.
New England Insurance Exchange, No. 55 Kilby Street.

Electric Heat Alarm Co.,
No. 113 Devonshire street, Boston Mass.

Gentlemen.—We have carefully examined your system of heat alarm, together with the thermostat used in that connection, and we are of the opinion that this apparatus will prove of value in giving timely warning of heated bearings.

We believe that in all fast-running machinery the installation of this apparatus would not only materially lessen the danger of fire from hot bearings, but would go further and very quickly pay for itself in preventing the destruction of valuable machinery, even when there was no probability of a fire resulting.

We heartily recommend the use of this apparatus to all parties subject to danger from heated bearings, and we believe that with a thoroughly installed system such danger would be reduced to a minimum.

Very truly yours,
C. M. Goddard, Secretary.

THE NEW PORTER & LEAVITT GRAVITY BATTERY FAN.

MORE than a year ago several sizes of neat and efficient small battery motors were placed upon the market by the Porter & Leavitt Electric Motor Company, of Providence, R. I. Notwithstanding the general unreliability of primary batteries and the necessity of their frequent and expensive renewal, many thousands of these little motors have been sold. Those having been fortunate enough to have storage battery current available for these little motors will testify as to what an inexpensive and reliable luxury the Porter & Leavitt fan outfit is.

Quite a number of people in New York City, for instance, have two such outfits—one for their residences run by storage battery and another on the desks in their offices, the storage batteries being rented from the Storage Battery Supply Company. A large number of people, however, cannot conveniently avail themselves of storage battery current, and in the majority of towns where such batteries are not rented as they are in New York, the use of such current would involve quite an initial expense in the purchase of one or two cells of battery.

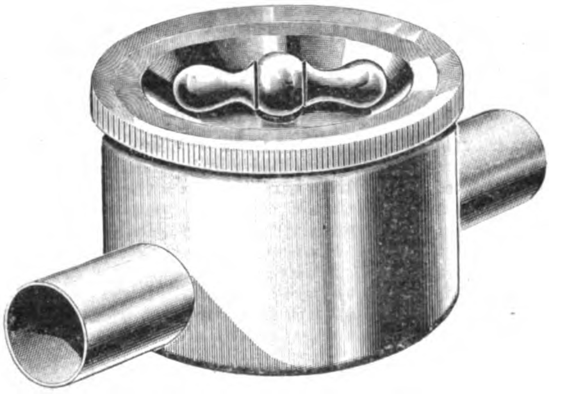
A large number of alleged successful cheap primary batteries have been placed upon the market within the last year or two, the use of which has often proved disappointing. The Porter & Leavitt Co., however, seem to have solved the problem of a primary battery fan outfit, by having succeeded in specially winding a fan motor for service on gravity batteries in groups of two or three. One of their fan outfits, for instance, they run for months, night and day, from six cells of ordinary gravity battery arranged in three pairs, connected in series, each pair being in multiple. The cost of such an arrangement is computed by the company to be 1¼ cent for 24 hours' constant work, although were the cost to be 10 times that much it would not be excessive as compared with the comfort involved.

The new gravity battery motor, the advertisement of which will be found in another part of this paper, is mounted on a polished cherry base, provided with a two-point switch—one point being used when the fan is in motion and the other switching into circuit a resistance of 15 ohms in order that the gravity batteries may not be on a dead open circuit while the fan is idle.

Now that a fan has been devised for the good old reliable gravity battery, the business outlook for the Porter & Leavitt Co. at the beginning of the warm season is particularly bright.

NEW TEN-AMPERE "FLUSH SWITCH."

THE new 10-ampere "Flush Switch" illustrated herewith, is manufactured by the Interior Conduit & Insulation Company of New York, at the suggestion of a prominent architect and is a production which has received high endorsement and commendation from the electrical trade. The engraving shows the many desirable features of the article. A notched cover is indented so as to allow the handle of the switch to be "flush" with the wall on which it is placed and a brass rim extends around the edge so as to protect the wall from soiled hands when unscrewing the cover, and at the same time serving to impart a finish to the switch when placed in position. The advantages of this switch are at once apparent and the article instantly commends itself to the attention of architects and others interested in rendering the various appliances used in conjunction with incandescent electric lighting ornamental and unobtrusive, as well as useful.



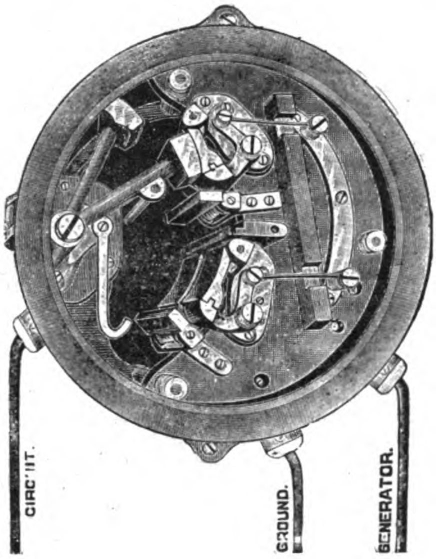
TEN-AMPERE "FLUSH SWITCH."

THE BUCKEYE ELECTRIC CO.

THE BUCKEYE ELECTRIC COMPANY are putting on the market a new double-coil filament 32 c. p. lamp. The effect is magnificent. Business at both Chicago and Cleveland continues good.

THE UTICA QUADRUPLEX LIGHTNING ARRESTER.

THE cut below shows the Utica quadruplex lightning arrester, made by the Utica Electrical Mfg. & Supply Co., of Utica, N. Y. It is similar in construction to their simplex and duplex arresters, and is designed for street railway, light and power plants—where the old adage "that lightning never strikes twice in the same place" will not hold good. The lightning arrester here shown will take care of four lightning bolts in succession before requiring attention, and all the damage lightning can do is the melting of a fuse wire which can be readily replaced. The contacts are made of bronze metal and very heavy—mounted on slate, enclosed in water-tight iron case, the case being provided with porcelain bushings for the entrance of wires. There being no magnets used in this arrester, it is equally suitable for either alternating or direct currents of any voltage and ampereage.



UTICA QUADRUPLEX LIGHTNING ARRESTER.

THE WADDELL-ENTZ COMPANY.

THE WADDELL-ENTZ ELECTRIC CO., whose apparatus is well known to our readers, has sold all its rights and ceded its entire business to a new organization called the Waddell-Entz Company. The latter company has just taken up its quarters on the fifth floor of the new *Mail and Express* Building, at 203 Broadway, this city, and has already begun to enlarge its facilities for manufacturing the Waddell-Entz apparatus.

NEW YORK NOTES.

THE C. & C. ELECTRIC MOTOR CO., of 402 and 404 Greenwich street, have always been noted for the finish and excellence of their catalogues, and the last one just to hand is a beautiful production well worthy of the Bartlett Press, whose imprint it bears. It is in point of fact more elaborate than anything hitherto put forth by the C. & C. Electric Company, and may be said to mark a further stage of progress in the development of their large and expanding business. It includes not only a list of their motor and dynamos, but gives a careful description of all the supplies necessary for the complete equipment of electric light and power plants. Among these may be specially mentioned their own switches, while there are such specialties as their fans, blowers and other ventilating machines; automatic motor starting boxes, organ rheostats and organ attachments. The company of late have sold a large number of their standard generators. This part of their business has of late assumed large proportions, and already begins to rival, if not exceed, the motor output. Once or twice lately we have had occasion to illustrate power plants in which C. & C. generators were not less conspicuous than the C. & C. motors.

THE increasing business of the Rose Electric Light Supply Company, of St. Louis, has necessitated their opening a New York office. This office is located in room 232 of the Electrical Exchange Building, under the management of Mr. H. F. Gray. Mr. Gray will be glad to receive correspondence or calls from those who are desirous of purchasing second-hand electrical apparatus in first-class condition and is prepared to fill orders promptly. There has long been a necessity in New York City for a first-class house carrying a large stock of second-hand dynamos, motors, etc., and we believe the success of Mr. Gray and his New York office is assured.

Mr. Edward P. Thompson, New York, started nine years ago to test the practicability of establishing a successful business as a specialist in soliciting U. S. and foreign patents for *electrical* inventions. That this has been possible is illustrated by the fact that during the past month he has had entrusted to his care twenty-nine *electrical* foreign patent cases besides the usual numbes of U. S. electrical cases.

The Premier Electric Co., 17 and 19 Whipple street, Brooklyn, have now issued to the trade a circular as to their basic patent, 321,049, controlling the type of motor that they make. It will be remembered that an open letter of theirs on this subject was recently published in these columns. This circular amplifies and enforces the statements then made. Their motors of the three-pole armature type are known as the "Premier" or the "Challenge."

Mr. J. G. Bishop, late electrical expert with the J. A. Roebling Sons Co., has now joined the forces of the Safety Insulated Wire Co., of this city. Mr. Bishop's experience in the manufacture of insulated wires will no doubt make him a valuable addition to the staff of the Safety Co.

Mr. P. C. Burns, manager of the Peru Porcelain Works who recently spent some days in this city has returned West. He was well satisfied with his trip to the metropolis.

PHILADELPHIA NOTES.

Messrs. Queen & Co. are just issuing a revised price list of their "Magnetic Vane" ammeters and voltmeters, in which two forms are given, one with brass and the other with iron cases. The difference in price is occasioned only by a corresponding difference in material used and external finish, for both types are calibrated to the same degree of accuracy.

These instruments are extensively employed for switchboard purposes, and enjoy an excellent reputation. As decided changes in appearance and prices have been made it will be well for interested parties to obtain a copy of the special descriptive circular No. 330.

The Heisler Electric Co. are installing plants of their long-distance series incandescent lighting apparatus in the towns of Greenport, L. I.; Cartersville, Ill.: San Rafael, Cal , and at points in Montana and Mexico. The Heisler Co. have recently introduced some new and attractive designs in incandescent lamps for decorative purposes. These lamps are blown from colored glass, and are made in any candle power or for any current from 4 to 10 amperes and to fit any standard socket. Orders for these lamps have already been received from Mexico, Central America and Italy.

Messrs. Pepper & Register are installing a 1,500-light storage battery plant in the building of the American Fire Insurance Co., a 150-light storage battery plant in the house of Mitchell Harrison, of Chestnut Hill, and a 500-light plant in the house of Gen. E. Bird Grubb, of Edgewater Park, N. J.

Messrs. Schultz and Gaylord, of the Pennsylvania Electric Engineering Co., have just returned from an extended business trip through New England and the West. They report large sales of their Pennsylvania lamp.

Mr. M. S. Shapleigh has resigned his position as agent for the Electrical Supply Co., and will hereafter act as manufacturers' agent and jobber of general electrical supplies at his old address 244 Arch street.

Mr. T. L. Townsend returned last week from a most successful trip through New England and Southwestern Canada.

WESTERN NOTES.

Mr. W. F. Matteson, who for so long past has been connected with Wm. Hood, the dealer in specialties at 239 La Salle St. as electrician, has resigned and accepted a position with the Patton Motor Manufacturing Co. and will leave shortly for Denver, Col., to look after the equipment furnished by that company to the street railway company there. Mr. Matteson is a bright young electrician and with his energetic and pushing qualities is well fitted for the new line of work he has undertaken.

The Electric Appliance Company report large sales of Meston alternating current fan motors. Although the season can hardly be said to have opened up, they are nevertheless considerably behind on their orders already and have had a demand far in excess of their expectations. The demand for "Canvas Jacket" wire is also very heavy and they are falling behind on orders, as the factory is crowded to its utmost capacity.

The Buckeye Electric Co. are having a good demand for their Buckeye coiled filament lamp for central stations and electric street railways, and the Chicago office, under the able management of Mr. J. H. Cooke, is securing a large number of such orders.

The Central Electric Company are putting on the market a very compact little fan motor, made in sizes 1/6, 1/8 and 1/4 h. p. These motors can be used on desks, and can be attached to the wall by a simple device, the whole being the product of the Interior Conduit & Insulation Company, for which the Central Electric Company are general Western agents. The price asked is a modest one, and they should command a ready sale. Mr. William H. McKinlock, president of the Central Electric Company, has just returned from New York. Dr. John McKinlock of the Central Electric Company has recently been confined to his house by sickness, but is again at his desk.

The Standard Railway Supply Co., Chicago, have opened handsome offices at suite 1117 Monadnock Building, and will deal in mechanical railway specialties. Mr. G. Meyers, well known in street railway circles, is the manager of the new concern.

Mr. Geo. Westinghouse, Jr., has succeeded in getting his World's Fair lighting bond reduced to $500,000, provided he can give one with two names to it.

Messrs. J. W. Godfrey, general manager, and Augustus Noll, electrical engineer, of the New York Insulated Wire Co., were Chicago visitors last week.

NEW ENGLAND NOTES.

Swan & Lane, have become associated as electrical contractors and have commenced business with headquarters at 194 Summer street, Boston. They will do a general electrical construction business, but will devote their time specially to the installation of isolated plants, and all kinds of wiring. Mr. Swan has had a large and varied experience in the electrical business, is full of energy, and popular with all who know him, having last been connected with the Boston Electric Light Company, as superintendent of the incandescent department. Mr. Lane has also had a varied experience, both in mechanical and in electrical engineering, having been connected with the Union Switch and Signal Company, of Pittsburgh, latter with Lane & Melcher, and lastly with Swan & Small who did all kinds of general electric work, in the manufacture and repair of dynamos, lamps, motors, etc., and general mechanical goods. With their past experience Messrs. Swan & Lane, ought to enjoy a large patronage, and will doubtless keep up the high record which they have already achieved.

The Jarvis Engineering Company, of Boston, have closed a contract with the Newport Illuminating Company of Newport, R. I., for six Armington and Sims compound condensing engines, for their new station. The sizes of the engines are as follows: Three engines, 12 inches and 18 inches diameter by 12 inches stroke; one 15¼ inches and 25 inches dyameter by 15 inches stroke; one 15 inches and 23 inches by 15 inches stroke, and one 13 inches and 20½ inches by 15 inches stroke. The station, which is to be erected on the old Richmond Mill property, will contain about 1,000 h. p. in engines, and three Climax boilers have been ordered from New York. The Jarvis Company will build all the foundations for the engines, and dynamos, and will raise the building considerably, and will do the complete carpenter work. The Jarvis Company been also closed a contract for the Worcester and Millbury Street Railway Company's new power station. This contract will comprise two new type tandem horizontal compound engines, of about 250 h. p. each, the boiler setting and complete foundations.

The Davidson Ventilating Fan Company, of Boston, have removed to more convenient and more commodious quarters on the second floor of 34 Oliver street, where they will have much more room to attend to their rapidly increasing business. They have just completed a ventilating system for the Boston Music Hall, which will secure comfort and fresh air to the patrons of the popular concerts at that establishment during the hot summer months They are also engaged in installing a ventilating plant in the Globe Theatre of this city, the order for which was given by Dixey for use during his engagement in "Iolanthe."

Samson Cordage Works.—This concern, of 115 Congress street, Boston, has been increasing its plant for the manufacture of "Samson" arc light cord and trolley cord. It has reached the limit of capacity with its present water-power, and to avoid the use of more steam it has purchased a water-power in the neighborhood of its factory, proposing to transmit the energy by electricity.

Drake, Payson & Whittier, of Providence, have a few "facts" which they can prove, and which they would like to impress on every user of electric light in New England. Send for a copy of them, as they are quite interesting.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

VOL. XIII. JUNE 22, 1892. No. 216.

MODERN AMERICAN TELEGRAPHIC APPARATUS.—III.

BY

F. W. Jones

QUADRUPLEX APPARATUS.

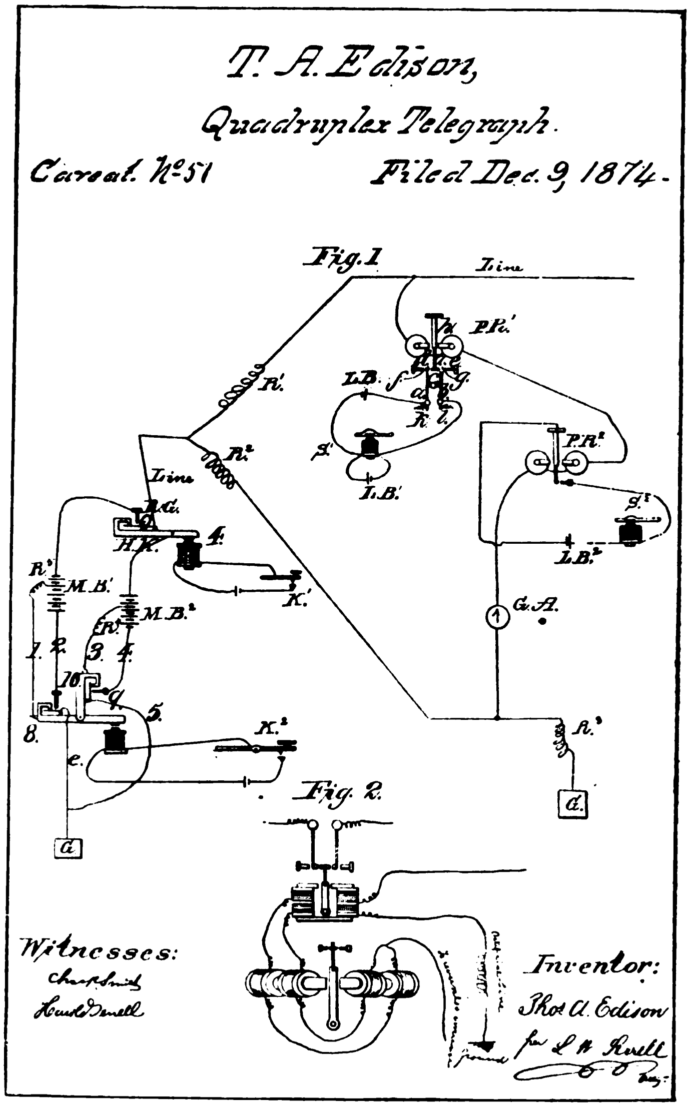
IN the *Journal* of Dr. P. Wilhelm Brix, Vol. II, page 224, published in Berlin in October, 1855, Stark of Vienna, after describing his system for transmitting *two* messages simultaneously in the same direction on one wire, he says that "with the method of double transmission in the same direction we may also combine that of *counter-transmission*, and hence arises the possibility of simultaneously exchanging *four* messages upon one wire between stations." Several European electricians worked at the problem but did not succeed in securing a satisfactory transmission of two messages in one direction.

A system very similar to the one introduced by Edison in 1874, was described by its inventor Dr. Schrader, of Vienna, in Brix's *Journal* Vol. VII, page 85, April, 1861. Schrader used two relays, one having two armatures (polarized) and the other one a neutral armature. He also used continuity-preserving keys.

The serious defect or "bug" in his system was the break or false signal in the circuit of the sounder of the neutral relay when the armature of the polarized relay was changing from back to front contact. A similar difficulty proved a bête noir in the Edison system, and still exists, defying an entire removal, although Edison and others have done much to counteract its detrimental effect in signaling; so that now the system very successfully accomplishes four transmissions twelve hundred miles with two automatic repeaters dividing the wire (160 lbs. copper per mile) into three approximately equal circuits. Or one thousand miles on a wire (210 lbs. copper per mile) divided by one repeater into two circuits.

One of the most ingenious devices for overcoming the defect already alluded to, is a compound polarized relay shown in Edison caveat No. 51, filed in the Patent Office December 9, 1874, a fac-simile of which is shown in Fig. 1. It is described in the caveat as follows: "In Fig. 1 of diagram P R′ is a polarized relay worked by increased and decreased currents. The tongue *h* is held equidistant from the points *d*, *e*, by the two arms *a*, *b*, which arms are held against *c* by their spiral springs *k l*. These arms have platina points *g f* and the tongue *h* when the weaker battery which works the other polarized relay P R² is sent, remains centred by the arms *a*, *b*, because the power of the magnet is insufficient to overcome the spiral springs *k l*. When thus centred, the platina point of the tongue is in contact with both the platina points on the lever *a b* and the local circuit of the sounder is closed but the sounder itself is not closed because it is placed in a bridge wire or a balance of batteries."

"Supposing the double-lever sounder at the distant station is closed the main battery is increased several times in strength. This increased current coming [going] over the line and passing through the polarized relay P R is sufficient to overcome the springs *k*, *l*, and the tongue goes to the right or left according to the polarity of the current, say to the left. In doing so the local circuit is broken between the tongue and lever *b* allowing the battery L B² to close the sounder. The tongue being to the left and the sounder closed and the operator at the distant [station] should commence signaling to the relay P R² by reversing the battery, then the tongue *h* would fly from one side to the other at every reversal, but the local circuit will not be closed, for just as the tongue *h* comes in contact with the lever *b* it leaves *a*, thus keeping the local open and the



FIGS. 1 AND 2.—EDISON'S CAVEAT OF 1874.

sounder closed, so it is obvious that although the effect of the reversals is to constantly work the tongue of P R^2 it will produce no effect on the sounder, which is essential for obtaining perfect signals. M B^1 and M B^2 are the two main batteries, say, of 100 cells each; M B^1 has zinc to line; M B^2 has copper to line."

Fig. 1 in diagram shows a bridge and Fig. 2 a differential arrangement; the other references will be readily understood by inspection.

The quadruplex had been put in operation, prior to the date of this caveat, by Edison between New York and Boston 240 miles with two single-wound relays, (one polarized and one neutral) on the bridge plan, with what is well known as Edison's "bug trap;" that is, one up-stroke repeating sounder working from the back contacts of the neutral relay, and by its up contacts actuating an ordinary sounder. The bridge system was adopted by the Western Union Telegraph Co. also for longer wires, as it was thought the effects of static induction could be better compensated.[1]

Edison had placed a condenser around the neutral relay in the bridge to hold its armature steady during the reversal of the distant main battery.[2] In August, 1875, I found that a condenser could be applied to differentially wound relays to steady the neutral relay, and the first circuit on this plan went into operation between Chicago and Buffalo with a repeater at Detroit.[3] In April, 1876, Mr. G. B Prescott, who at that time was electrician of the Western Union Telegraph Co., applied for a patent issued May 15, 1877, applying the condenser to an independent electromagnet acting independently but in conjunction with the neutral relay magnet upon an extension of its lever in the bridge system.[4] In 1876, Mr. Prescott's relay was superseded by a compound polarized relay identical in principle and operation with P R^2 shown in Edison's caveat and shown in Prescott's work, page 849, and described by him as one of several important modifications by Messrs. George B. Prescott and Gerritt Smith, and also described and claimed by Mr. Smith in his patent No. 185,589, Dec. 19, 1876, (one-half assigned to G. B. Prescott). This relay had very extensive use and when carefully balanced and adjusted, aided by Edison's bug trap and condenser gave better signals than had hitherto been obtained upon the neutral, or No. 2 relay, as it is known in telegraph circles.

Owing to the difficulty of maintaining this relay in working adjustment the Western Union Telegraph Company shortly after adopted the general use of the differential system substantially as first put up between Chicago and Buffalo. Mr. Gerritt Smith afterwards modified Mr. Prescott's bridge relay having an independent magnet for condenser, by winding an extra or third coil upon the differential neutral relay and discharging the condenser through this coil, at the same time introducing resistance between the relay and earth so that the condenser would be charged to a higher potential. It is this system that has recently undergone another change in the displacement of the Gerritt Smith arrangement by the Frier relay described in THE ELECTRICAL ENGINEER, May 4, 1892, page 454.

In 1885, I arranged for the Postal Telegraph-Cable Co., the following system which is worked on wires of all kinds and lengths and has received the unqualified approval of the managers and chief operators.

In Fig. 3, D, D^1, D^2, D^3 represent four compound shunt-wound dynamos. Two of these dynamos are of low potential (one plus and one minus) and two are of high potential (one plus and one minus), and they are connected to a new style of pole-changer, marked P C, through a four-button switch S W.

P C makes four contacts, 1 and 3, when it opens, and 2 and 4 when it closes Contacts 1 and 2 are adjustable springs and continuity preserving, as the end S of the lever of P C moves up or down. The contacts 3 and 4 are fixed, and a space occurs when the end L of P C moves from one to the other. The ends of lever L and S are insulated by *i* from one another. It will be seen that the dynamos are connected as follows: One hundred minus to contact 1, one hundred plus to contact 2, three hundred minus to contact 3, three hundred plus to contact 4. Two wires lead from P C to an improved form of single transmitter S T. One wire connects L with contact point C, the other wire connects S with the lever L^1. The spring *y* of S T connects through a three-point switch, and a regulating resistance R with the dividing point of the relay N. P R is a polarized relay, and I C is an induction coil having three windings of one hundred ohms each. Two of these windings are included in the main and artificial circuits in the usual differential manner. The third winding is connected with the third electromagnet, marked M^2, of the relay N.

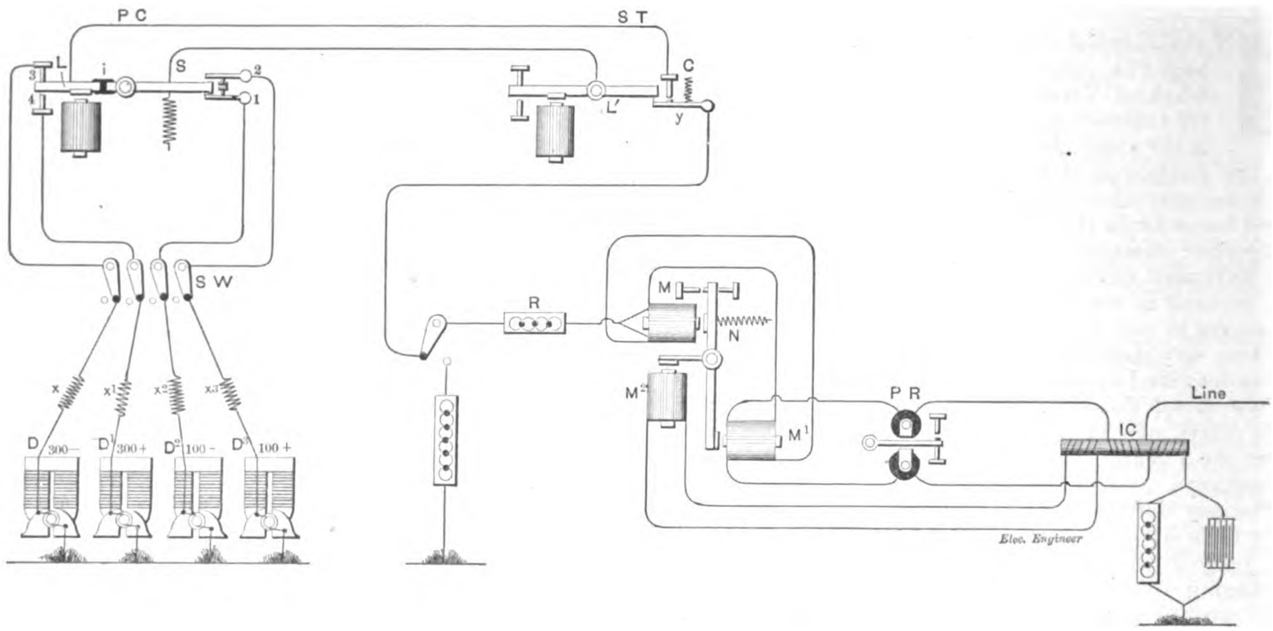


FIG. 3.—JONES DYNAMO QUAD AS EMPLOYED BY THE POSTAL TELEGRAPH-CABLE CO.

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1. See Prescott's "Electricity and Electric Telegraph," page 835.
2. Ibid, page 841.
3. Patent No. 191,439, May 29, 1877; also *Journal* Am Elec. Soc. *Vol. I.*, p. 26.
4. Prescott. "Electricity and Electric Telegraph," page 839.

The electromagnet M and M^1 are in series differentially in the line and artificial circuits, the total resistance of both magnets in either circuit being about 300 ohms. The polar relay P R shown in perspective in Fig. 4, has the usual resistance of 400 ohms in each winding.

The resistance R between the three-point switch and N is for the purpose of reducing the potential of the dynamos when it is desired to work a line circuit of shorter length than is designed for the normal potential of the machine. Thus from the same dynamos several quadruplex circuits of varying lengths or resistances may be worked, provided the normal potentials of the machine are adapted to the circuit of highest resistance. The diminution caused to the incoming current by the insertion of R is counterbalanced on the relays largely by the greater quantity of the incoming current that will go to earth *via* the artificial circuit, thus traversing two sets of relay convolutions.

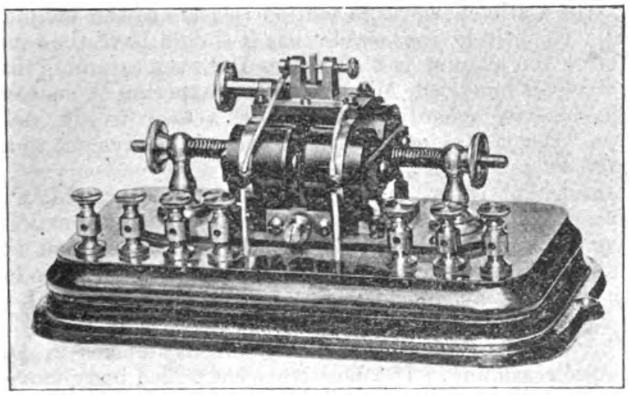

FIG. 4.—JONES POLAR RELAY.

Number 2 relay, N, is shown on a large scale in Fig. 5. A and A^1 are the differential main line electromagnets connected up in series. B is the electromagnet through which the secondary circuit of the reversal coil I C, Fig. 3, is connected. The lever of the relay is made of aluminum and carefully counterbalanced by giving the armature lever of A^1 an angular shape. A brief inspection of Fig. 3 will show that the outgoing currents passing differentially around the reversal coil I C produce no effect upon the third winding connected with magnet M^2. The incoming signaling current, however, during its approach and retreat sets up in the secondary coil of I C induced currents which momentarily energize electromagnet M^2 which holds the lever of the relay in opposition to the force of the retractile spring. Following is a table of inductance and time constants of some of the instruments alluded to :

Name of Relay.	1. Coil resistance. Ohms.	Distance of armature from cores. Mils.	Continuous current. Milliamperes.	Inductance. Henrys.	Time constant. Seconds.
G. Smith, 3 coil	306	4.	6.5	1.157	.0037
Frier, self-polarizing	395	4.	6.5	2.131	.0054
Jones, triple magnet	293	4.	6.5	1.583	.0050
Reversal coil, primary	100	40.	6.5	0.464	.0046

In any circuit the whole self-induction is equal to the sum of the inductance of all its parts. A quadruplexed circuit of the Postal Telegraph-Cable Co., including 390 miles of copper line wire, with an inductance of 2.53 henrys, with 60 milliamperes of current, and a time constant of .0029 second, also includes the coils of six instruments, which have an aggregate inductance of 6.71 henrys, with a current of 6½ milliamperes. The time constant of this wire and apparatus, so far as inductance is concerned, is .0037 second, and this may be reduced by increasing the resistance of the circuit without adding to its inductance. The time consumed in this circuit by the sending station's currents rising to 0.634 of their final value in the coils of the three instruments at the receiving end, so far as inductance alone is involved, is approximately .0014 second, allowing 1,000 ohms inductionless resistance in the dynamos at each end, and 880 ohms in the line wire. It will be noted that the three line coils of the sending station's apparatus are inductionless to outgoing currents. The advantage of the triple-magnet form of relay, shown in Fig. 5, becomes apparent, as the time constant of the main relay coils in series is no greater than the time constant of either of these coils separately; but to attempt to maintain the same magnetic effect by placing the convolutions all on one set of cores would be to increase the inductance which is proportional to the square of the number of turns included in one bobbin.

The retardation due to the electrostatic capacity of the line wire is most seriously felt upon all long circuits, and seems to be the greatest cause of mutilation of signals upon the No. 2 relay.[1] Iron wires do not charge and discharge so quickly as copper wires. To entirely remove inductance from a relay is to render it incapable of exerting any magnetic pull, so that all relays must be adapted to the work they are required to perform, just as a strong clumsy horse is selected for the dray and a fleet nimble one for the race-track.

Besides the inductance and retardation alluded to, there is also a possibility of the pole-changing transmitter, such as illustrated on page 454 of THE ELECTRICAL ENGINEER, of May 4, and also in Fig. 3 of this article, marked P C, having their points opened so wide that the time consumed by the lever in crossing to reverse the current will exceed the time the circuit requires to fall to zero.

In the case of the system shown in Fig. 3 the relays have been designed to utilize the signaling current as much as possible for magnetic effect, and at the same time to possess the least mechanical and electromagnetic inertia. It is true that an additional resistance and inductance have been added to the circuit by the primary coil of the reversal coil I C to the extent of 100 ohms and .46 henry, but

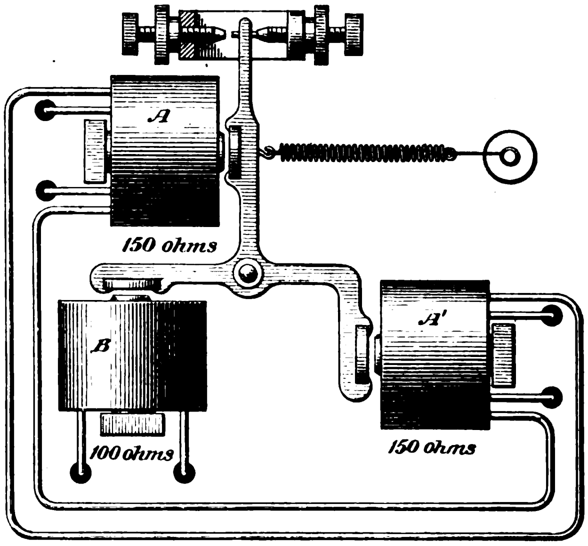

FIG. 5.—JONES QUAD TRIPLE MAGNET NO. 2 RELAY.

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[1] See Preece and Sivewright, "Telegraphy," (1891 edition, page 160).

in practice it is found that the important service of this coil in steadying the tongue of the relay during the interval of no magnetism is so great as to render entirely unimportant such additional inductance. With the admirable bug trap of Edison this system has worked a direct wire between New York and Chicago without repeater for a long period. It is obvious that a relay, otherwise well designed electrically for the work required of it, may be handicapped by mechanical inertia.

As I am an interested party in some of the apparatus described, and am anxious to place before the readers of the ENGINEER facts not hammered entirely upon my own anvil, I submitted the new and ingenious relay of Mr. Frier, and the Jones triple-magnet No. 2 relay, referred to in the preceding table, to Assistant Manager Shirley, of the Postal Telegraph-Cable Co.'s New York main office, with the request that a strictly first-class operator give them a trial, which was made upon the New York and Pittsburgh circuit, 470 miles, under the supervision of Mr. Minor M. Davis. Mr. S. W. Churchill was assigned to the test, the circuit being in full operation, and nothing was known by him of the names or inventors of the two relays. His report is as follows:

> F. W. JONES, Chief Electrician.
>
> *Dear Sir.*—In accordance with your request, I will give you my opinion concerning the practical working of the instruments which were tested on the Pittsburgh quadruplex, this morning. I have no hesitation in saying that in my opinion the one tried last, or the larger, double-decked relay, worked decidedly better than the smaller, or low relay. In the case of the smaller one, the sending came droppy and uneven, and although it was possible to receive the matter sent (special matter), it would be difficult, if not unsafe, to receive commercial or cable messages.
>
> When receiving from the larger relay there was no dropping or unevenness, and although the sending was much more rapid than when trying the smaller relay, every dot came clearly and distinctly, making it as easy to receive as though it were the first side of a quadruplex. In a long experience as an operator I never worked on the second side of a quad where the sending came clearer or better.
>
> S. W. CHURCHILL,
> Operator.
>
> 187 BROADWAY, NEW YORK, April 27, 1892.

This was the only means at my command to secure an impartial comparative test. In each case the Edison bug trap was used in the usual way. I gave no figures of merit in the foregoing table of measurements because none are possible; it requires actual operation to develop both mechanical and electrical qualities.

The test, of course, is open to a suspicion of having occurred in too friendly an atmosphere; yet it is a starting point for one that will be more conclusive to your readers.

DR. JACQUES' EXPERIMENT ON THE NATURE OF THE ELECTRIC CURRENT.

BY

Townsend Wolcott.

THE experiment of Dr. Jacques[1] seems to have created quite a sensation, and to be regarded as very remarkable, at least by some. In the humble opinion of the writer the most remarkable thing about it is that a man of sufficient intelligence to conceive and carry out such an experiment should think that he is following Maxwell's reasoning when he makes an "ether current" equal, or in any way equivalent to an electric current.

Maxwell distinctly states in article 769, from which Dr. Jacques obtained the foundation of his experiment: "This moving electrified surface will be equivalent to an electric current sheet." That is, the moving statically electrified surface is equivalent to an electric current, and not to the ether through which the surface may be conceived to be passing. Maxwell makes no mention of ether as it is not necessary to his reasoning.

Personally, I do not think Maxwell's experiment would succeed even if it were possible to try it, as the four things involved, (two surfaces and a static charge on each) are fixed with regard to each other; there is absolutely no relative motion. In the next experiment suggested by Maxwell, and which was successfully tried by Prof. Rowland, the static charge is in motion relative to the magnet, and it is entirely reasonable that it should have the same effect on the magnet as a current. But even assuming that Dr. Jacques has tried Maxwell's first experiment successfully, he has, according to Maxwell's own words, only shown "that a moving electrified body is equivalent to an electric current."

I think that if Dr. Jacques' disciple, Mr. Berthold, will carefully read the *words* Maxwell has written in articles 769 and 770, without reading *ether currents* between the lines, he will see that these two experiments are intended to prove the same thing as pointed out in the editorial in the ENGINEER of May 18.

There are several other trifling inconsistencies in Dr. Jacques' reasoning. If a positively electrified body moved in a given direction is equivalent to an electric current in that direction, then a negatively electrified body moved in the same direction is equivalent to a current in the opposite direction. Therefore, when his plates were oppositely electrified, the electrostatic attraction ought to be diminished by the electromagnetic action, if there were any, as the latter would be repellent. This is a somewhat damaging fact, as the deflections which Dr. Jacques expected to get, and which he thinks he did get, depend upon the repulsion of similarly electrified plates being diminished, and the attraction of similarly electrified plates being increased. Again, even granting that the constellation Hercules is stationary absolutely, it does not follow, of necessity, that the ether (if there be such a thing) is stationary relative to Hercules. Moreover, if an electric current be an ether current, a static electric charge is a charge of ether (which, by the way, necessitates a revival of either the one-fluid or the two-fluid theory of electricity); and the Doctor first charged his plates with ether and then moved them through the ether. This proceeding on the part of the learned experimenter bears a strong analogy to the action of the bear hunter, who, by some mischance, became the bear hunted, and who escaped from his infuriated pursuer by first crawling into a hole and then pulling the hole in after him.

Why, may I ask the Doctor, does not the tremendous ether current which is rushing past our globe manifest itself in ordinary electromagnetic phenomena, rendering unnecessary his ether-charged plates? Perhaps it does. Perhaps it is the cause of terrestrial magnetism, and as he has not yet stated whether the direction of the ether current agrees with what is known by the ordinary convention as the direction of the positive current, or the reverse, his best plan would be to study out the direction necessary to make it account for terrestrial magnetism, and another great discovery will reward his diligence.

THE BEST FREQUENCY FOR ALTERNATING CURRENTS.

HAVING regard to all the circumstances of the case, says *Industries*, we believe the American frequency of 130 is about the right one, and that low limits, such as 40 or 60, are a mistake. Recently we have seen 20 periods per second proposed. This would be ruinous both to the pocket and to the eyesight. Helmholtz found that the eye could distinguish 25 periods per second. This low frequency would probably be unworkable in the dynamos and motors, and especially in the transformers.

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[1] See THE ELECTRICAL ENGINEER, May 18, 1892, "What Electricity Is."

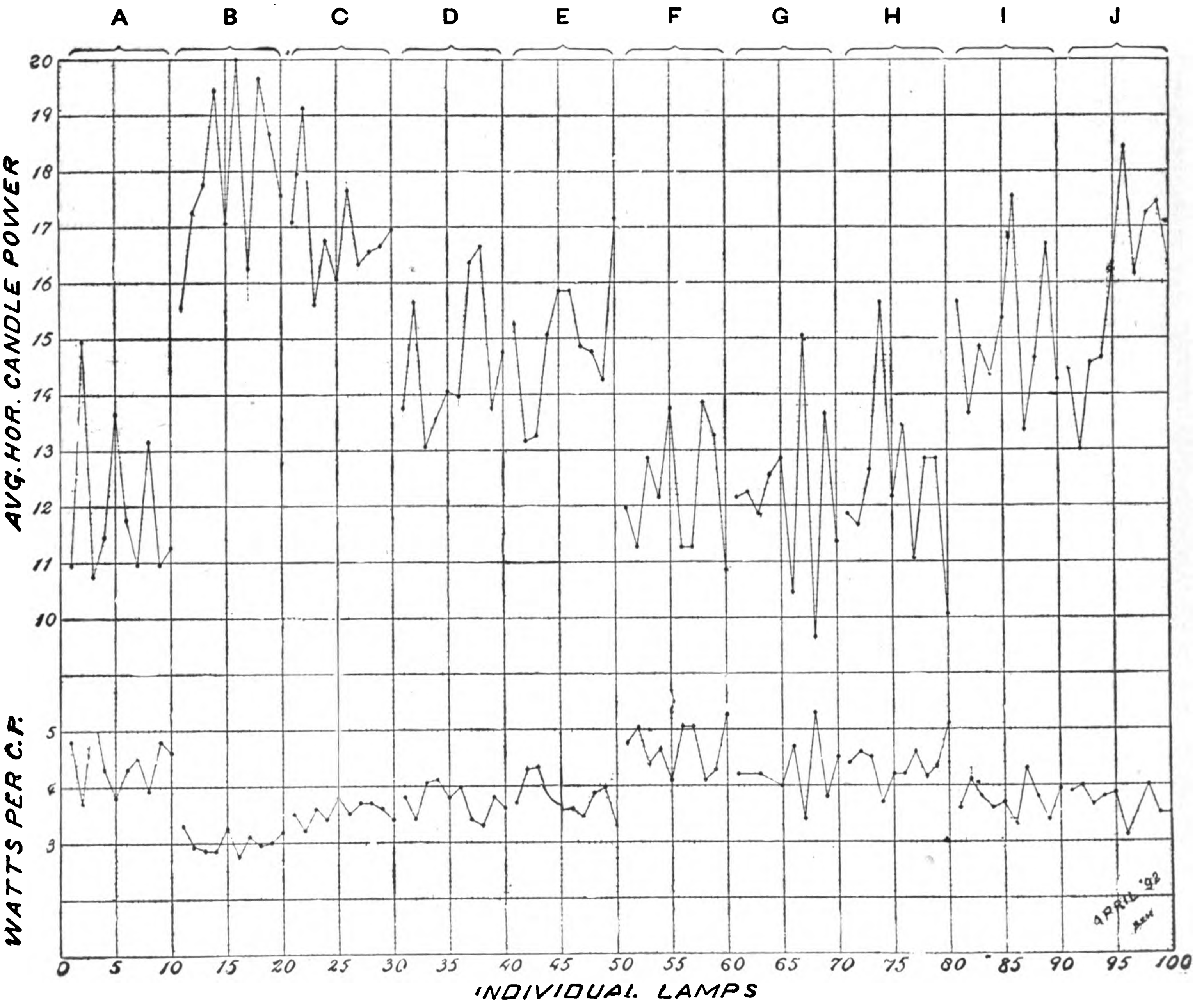
THE COMMERCIAL RATING OF INCANDESCENT LAMPS.

BY

Charles Wirt

The accompanying diagram shows simply what the market affords in the case of incandescent lamps, so far as may be gathered from results which do not include the life history of the specimens tested. The test was undertaken merely to get a fair idea of the character of the output which has now become the product of a large number of factories.

For the purpose of the test lamps were obtained from sixteen different makers. These were bought in the ordinary way of business and there is no reason to suppose that any of the specimens are better or worse than the ordinary run of their kind. Of the lamps so bought, ten of each of ten kinds were tested. All the lamps tested are represented in the diagram, for which the following explanation will be sufficient: Numbers at the bottom refer to the individual numbers marked on the lamps before the test. In the vertical line referring to each lamp are two points, one indicating the watts per candle by reference to the scale and the one above indicating the average horizontal candle-power when the lamp was burned at the volts for which it was marked. The first ten numbers represent lamps of one make, and so with each series of ten. The lines connecting the points are to show clearly which points belong to one set and have no other significance.



Commercial Rating of Incandescent Lamps.

The tests were all made in the photometer-room of the Electrical Supply Co., at 104 Michigan avenue, Chicago. The photometer used had a scale length of 200 centimetres, and was provided with a Methven gas standard by Alex. Wright. When first used a few months ago this standard was checked by measurement of incandescent lamps obtained for that purpose from Prof. Nichols, of Cornell, and by comparison with standard candles, both these checks showing the gas standard to be correct within the limits of observational error. The scale of the photometer was marked to read candles direct, and the spot was capable of being read to about $\frac{1}{10}$ candle at 16 C. P., when the observer's eyes are in good condition for work. To get the average horizontal C. P., the lamp socket was revolved about 600 times per minute by a motor which was placed at a distance and connected to the spindle by a light belt to avoid any vibration of the photometer. Sliding contacts are of course necessary to the lamp socket, and these consisted of the conical step at the lower end of the spindle, and of a double bronze spring, bearing on a brass ferrule below the socket. The loss at these contacts was measured while running with the usual current, and was found to be less than $\frac{1}{1000}$ volt; too small to consider. The results of the rotation of the lamp are in every way satisfactory. It has been the writer's observation that to get the average horizontal illumination in any other way a large number of separate measurements must be made, as the effect at different angles is erratic, due apparently to reflection from the inner surface of the glass as much as to the carbon shadow.

All the lamps tested were marked 50 volt with the exception of one lot which was marked 51. All were marked 16 C. P. except one lot which had no C. P. mark, and which were assumed as 16. All candle power observations were made by the writer. From four to twelve readings were made on each lamp according to the momentary condition of the observer's eyes and the momentary steadiness of the working current, and these readings averaged. Current and voltage were read by Mr. S. E. Hitt, who used a Weston direct current voltmeter reading to 150 volts, and a Weston ammeter reading to 1.5 ampere. These instruments were both checked against a Wirt standard voltmeter, using a shunt for the current reading, and a slight error in the former was allowed for.

No comments are made on the diagram, which speaks for itself. The following points should be uppermost in the minds of lamp-users, but some may not have yet learned them and others may not object to being reminded of them:

1st. The best lamp to buy is the one that gives the light needed for the least money—all expenses considered.

2d. The most satisfactory light to the user, other things being equal, is the one with the greatest uniformity; uniform from lamp to lamp, from moment to moment, from day to day. The difficulties in the way of securing this uniformity are great and occur in the rating of the lamp, in the regulation in the station, in distribution of the current, and in the tendency of lamps to "lie down" after use for a short time, dragging out a miserable existence of little use to any one except the manufacturer who wishes to make a life record of seventeen thousand hours, more or less.

3d. A good lamp badly rated will give worse results than a poorer lamp accurately rated. Lamps which are to burn together must have uniformity in candle power and efficiency. Variation among individual lamps in efficiency will have as bad an effect on lamp life as momentary variations in the E. M. F., and with the difference that it is a fault beyond the control of the operator.

4th. "Life" has no economical significance except when considered in connection with efficiency. Nominal efficiency, or efficiency when the lamp is fresh, has no such importance as the *average efficiency*, which in the usual sense of the term is equal to the total watt hours supplied during the useful life of the lamp divided by the total candle hours obtained during the same time.

"CANNOT AFFORD TO MISS ONE."

A SUPERINTENDENT of construction for one of the parent companies, who happens to be at work just now in Pennsylvania, writes us to give his address, and says: "I have not received last week's copy of your paper. It is so valuable to me I cannot afford to lose even one."

WHAT AN ELECTRICAL DICTIONARY MIGHT BE.

BY

Park Benjamin

THERE are certain propositions concerning an electrical dictionary which I take to be pretty nearly axiomatic:

1. The principal function of a dictionary is to define terms; that of a cyclopædia, to describe things. A cyclopædia may trench upon the province of a dictionary without losing its character. A dictionary cannot trench upon the province of a cyclopædia without containing surplusage and becoming itself a cyclopædia of an imperfect kind.

2. An electrical dictionary is intended for electricians and for those directly interested in ascertaining the exact meaning of terms. It is not intended for the lay reader; nor as an elementary text-book. The general public can find all the electrical terms that it needs set forth, with sufficient fulness, in existing text books and in the great dictionaries, such as the "Century."

3. The terminology of a science, unlike the words of a general language, is not the product of custom and slow growth. The terms are coined once for all, usually to represent, in brief form, a newly discovered fact or thing, and to avoid circumlocution or an unwieldly phrase for its expression. The maker of the term, as a rule, evolves it arbitrarily. In the great mass of cases, it is as often a mere word symbol as anything logically descriptive. It is the outcome of the sponsor's arbitrary judgment controlled by the existing state of the art.

4. Electrical words are the product of many minds acting at many different times. A person saturated with existing knowledge will create a word conformably to it; but just to the extent that his knowledge may be imperfect, so may his word become out of harmony, or even bear no relation to the existing terminology. From this it results that similar words may have different meanings at different times, and even at the same time.

5. From the foregoing it also results that the opinions of any one man as to the meaning of all the terms in a technical language are not proof of what the meanings are, but simply go to exhibit the condition of his own mind as influenced by certain external impressions. Another mind might receive a totally different set of impressions, and his own mind might equally receive a totally different set of impressions at another time. A dictionary, therefore, wherein one man attempts to define all the terms of technical language by the impressions formed in his own inner consciousness, must, of necessity be not a dictionary of what the terms *do* mean but of what he, as an individual, *understands* them to mean.

6. Progress in electrical science is a matter of days,—almost of hours. We are not only constantly discovering new things, but new views of old things. A dictionary which sets forth the views we take to-day, becomes inaccurate to-morrow, and perhaps wrong next year.

The science of electricity differs from other great branches of human knowledge in that we can clearly see the beginning of it. It does not get lost in the mazes of antiquity. It is practically all included between Gilbert's "De Magnete" and the last number of THE ELECTRICAL ENGINEER. The first electrical dictionary occupies one page of Gilbert's book, and contains about a dozen or so definitions. Among others, that of "electrics," "those things which attract for the same reason as the amber (electrum)." We have been adding to Gilbert's list for 292 years. If that great intellect could come back to earth again, our modern electrical dictionaries should show to him how the talent left by him in our keeping has multiplied; its whole multiplication, and not so much of it as we may happen to be using for our daily needs in the year 1892. If we want to describe the characteristics of a great river, the nature of its water, of its source, of its bed and of its banks, the speed of its flow and how it has been harnessed to human uses, we do not do so by specifying the height of the tide on a certain day and by the aid of an instrument filled with the errors of personal equation.

The dictionary made up of definitions arbitrarily evolved by the author is fast becoming obsolete. A glance at the new dictionaries of the great languages will show that modern philologists take into account all meanings of a word as understood by all competent minds, both past and present; and this, be it noted, in dealing with a general language which is necessarily of excessively slow growth, and where words stay unchanged for centuries. It is all a part of the tendency of modern science (a tendency so magnificently illustrated by Gilbert first and of late years most minutely by Darwin) to place before the student all of the data necessary to enable him to form an intelligent judgment for himself. The world nowadays accepts no theory, except provisionally; and it does not care a snap for any man's opinion unless it is backed up by the logic of incontrovertible fact. It is done with second-hand philosophy. It wants to see and hear the evidence; and the evidence itself, and not what somebody thinks the evidence is.

As I said before, all of this evidence in electrical science has accumulated within a space of three centuries. In making a dictionary we deal with recorded evidence. We can safely leave out terms which are so evanescent that no one has seen fit to write them down. This recorded evidence is available. It would not make a large library, as large libraries go, if the whole of it were massed together.

In fact, the reprinting of a library containing all known strictly electrical literature, would probably be considered a bagatelle by the Government Printing Office at Washington, and if made into volumes of similar size, would probably not aggegate one-quarter as many as have been sold of any one of the more popular, poor but pious novels of the late Mr. E. P. Roe. I have not counted the titles contained in that dreadful muddle, the catalogue of the Ronalds library, which includes not only the books which Sir Francis Ronalds had, but apparently every book that anybody else ever told him about; likewise newspaper clippings, and all sorts of fugitive literature, while its omissions are numerous and unaccountable. Judging from an experience of some ten years in building up my own collection, however, I should hazard as a fairly safe guess, that all the electrical terms coined between 1600 and 1870, together with all the uses of these terms, could be found in books and other publications aggregating not more than one-fifth of the total mass of electrical literature which has appeared. The immensely rapid progress since 1870, and the large increase in technical literature, notably newspapers, will doubtless require the investigation through later years to extend over a much larger percentage of the publications.

If the electrical dictionary of the future is made on the plan thus broadly outlined, it will define not only every term which has been used or proposed, but will define that term in the original language of the man who proposed it, and give his name, and state when he did it. Not only this, but it will give every meaning which that term has successively had, or enough meanings to show what material changes have occurred, and when, since it was first proposed. If it contained descriptive matter at all, that matter would merely be such as is best calculated to show how the term is or had been used. It would not be necessary in a book addressed to skilled electricians to give pictures of a voltaic cell, or a Wheatstone bridge, or a typical resistance coil, in order to explain what such things are. It would resolutely bar out definitions which do not define—such as attempts to state what electricity is by the time-honored though circular process of giving a new name to it.

Instead, for example, it would give all the definitions of electricity from Gilbert's explanation of the word "electric," the doctrine of effluvia, and Charlton's first use of the term "electricity" itself, down to perhaps Dr. Jacques' notion that the electric current "is a bodily forward movement of the ether." It would show, to give further examples, that such terms as "electromotive force," and "tension," and "charge," and "intensity," and countless others, had very different meanings from those of the present time, although they were abundantly used 70 years ago. That, for instance, even such a common word as "motor," or "electric motor," carrying with it as it does a practically undisputed meaning to-day, involved no idea of mechanical motion at the beginning of this century, and in fact, was Volta's name for his cell. It would show that many a capital definition has been made and forgotten. How many remember that Faraday defined "current" as "anything progressive?" It would show how the advancement of electrical science has been very like that of the zigzag lightning bending back sometimes on itself; that it is constantly taking up and adopting ideas long neglected; as witness the instances of Green, and of Ohm, and more lately, of Maxwell. It would show to the electrician all the meanings which the master minds of the science had given to a term, who its sponsors were, and at what stages of electrical history these significations were applied; unlocking, as it were, the mass of knowledge shut up in the word very much after the manner in which such writers as Trench and White have delighted in revealing the curious historical lore concealed in many oddly-formed words of our mother tongue.

In answer to the possible objection that such a dictionary would be of use only to people who take pleasure in grubbing into the past history of the science, I will give but one instance of its practical utility. A United States patent can be anticipated by what is shown and described in any prior patent or printed publication. There have been abundant cases (the storage-battery litigations, for instance) in which the courts and the experts have been called upon to explain the meaning of language contained in publications dating far back in this century. The language of these publications is too often interpreted by the meanings of to-day; and unless it can be shown to the courts by some convenient and available means that these meanings were just as non-existent at the time as was the invention which it is sought to overthrow by them, the courts are very apt to go astray. The principle of *lex temporis* applies to a scientific publication setting forth a generally accepted definition of the time just as much as it does to a statute once in force and now repealed; and it is just as absurd, for example, and in a sense just as unconstitutional, because *ex post facto*, to apply present significations to electrical terms used in the early part of the century, as it would be to apply the patent laws now existing to the solution of legal questions arising at that time and under the patent laws then in force.

The foregoing is not intended as a review of Professor Houston's practically new dictionary of electricity, but rather as an indication of what it is thought the dictionary of the future, constructed in accordance with modern scientific methods, might and perhaps ought to be. As an exponent of the type of dictionary-making which has hitherto generally prevailed, Professor Houston's work is probably as good as can be found. It serves the useful purpose of giving the latest definitions extant at the time of its publication; and probably it shows the general opinion of the electrical world as to the meaning of terms at its date. But, like all other works of its class, until sufficient time goes by to give it a new importance by reason of its scarcity and antiquarian interest, its practical value will be inversely proportional to its age. Subject to these objections, the utility of the book is unquestionable.

PLOTTING CHARACTERISTIC AND OTHER CURVES.

BY

Robert P. Dobbie

Having frequently had occasion to plot characteristic curves of machines, in some cases with small E. M. F. and comparatively large current, and in others with small current and very high voltage, I have found curves under these conditions to be so gradual that their true significance is not at once apparent to the eye. I have given the matter quite a little attention and have devised the following plan, which I use in my practice and find very satisfactory, and, I think, it will be of interest to some of the readers of the Engineer.

My method is to lay out the total amperes and total volts on an equal scale; for instance, supposing we have a machine of 1,000 amperes and 100 volts, and, supposing we used one foot to represent the 1,000 amperes in the horizontal direction, we would also use one foot to represent 100 volts. Of course in taking a characteristic curve, it is often necessary to go beyond the normal voltage at full load and the normal full load in amperes, but that does not affect the application of this principle; the normal full load of the dynamo is always a point on the diagonal of a square.

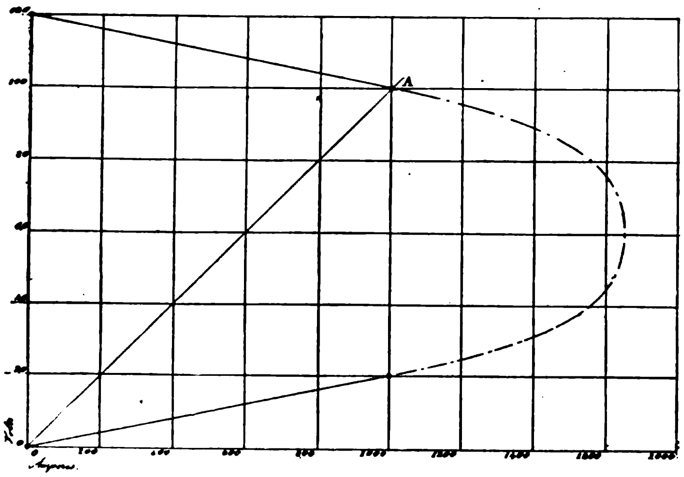


Fig. 1.

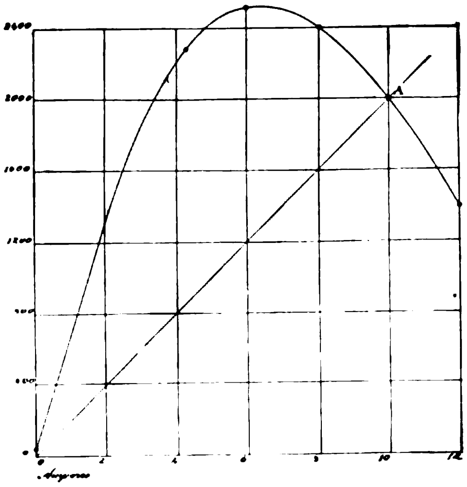


Fig. 2.

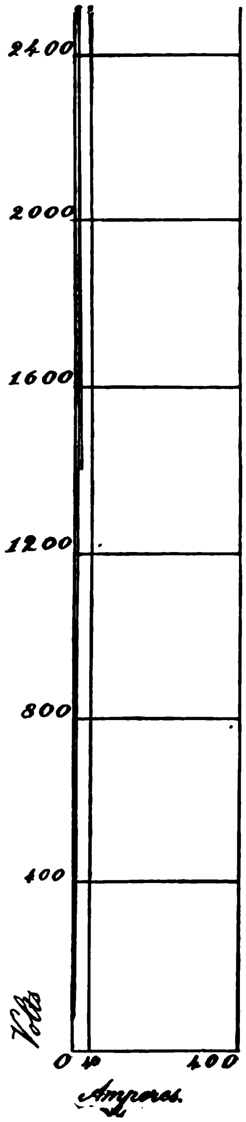


Fig. 4.

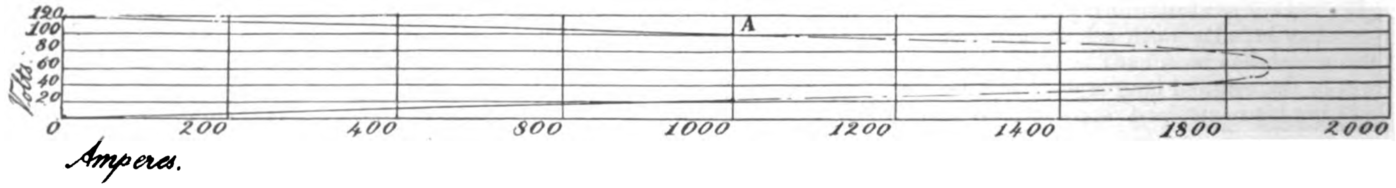


Fig. 3.

Referring to Fig. 1, we will suppose that 1,000 amperes and 100 volts is the normal full load output of a shunt-wound dynamo. This point, represented by a circle at A is equidistant from the zero line of amperes and volts; in other words it coincides with the diagonal of a square. In Fig. 2, which is a curve of a series-wound machine (not taken from actual practice), we have full load at 10 amperes and 2,000 volts. Here the point A is also on the diagonal of a square.

In Figs. 3 and 4 the same curves are plotted according to the usual rule and as laid down in Sylvanus P. Thompson's work, where scale of volts equals the scale in amperes; that is to say, if $\frac{1}{10}$ inch represented one volt, $\frac{1}{10}$ inch would also represent one ampere. It will be seen from comparison how very much easier it is to judge the curve laid out in the way I propose than by the usual method.

Another advantage is that two machines differing in size, but of the same general type, can be accurately compared; for instance, take two constant potential machines designed for 150 volts, one of them for 1,000 amperes and another for 500 amperes. If the physical properties of the machines were precisely the same, the curves would be identical; if the full load in each case were laid out to a scale of one foot, or any other convenient length, in the manner indicated, any variation due to quality of iron, etc., would be very apparent.

The principle here indicated can, of course, be applied to almost any of the curves now so largely used to exemplify problems in engineering; those curves that are continuous, such as a profile, speed and time curve, or line representing pull of a dynamometer, being exceptions.

EPICYLIC GEARING FOR ELECTRIC CARS AND ELEVATORS.

BY

Wm. S. Aldrich.

In a note recently printed[1] entitled "An Hydraulic Gear for Street Cars," it is stated that "A patent is about to be issued for an interesting hydraulic gear or clutching mechanism, the invention of Mr. Finis M. Barney, of Kearney, Neb. It is an application of the differential or epicyclic principle, with an hydraulic instead of a fixed connnection." At the end of the above article a modification is referred to, in which the armature and field both are said to revolve. Several features, of special interest to the electrical engineer, are here brought together; and the writer presents, in connection therewith, an outline of the work which he has done in this field during the past year.

The problem presented has been to devise some intermediate variable-speed transmission machinery, between the armature shaft and car axle, by which the electric motor, working at its best efficiency, may be driven at a uniform speed in one direction—while the intermediate gearing allows of the car remaining stationary, or being driven forward or backward at any desired speed within the limits of the combination.

The principle of what is known in mechanism as the *epicyclic train* has seemed to offer many ready solutions. As a train of gear-wheels, having a fixed or constant velocity-ratio, it requires two electric motors, capable of being *slightly* varied in speed with respect to each other, in order to produce a rotation of the arm of the train, keyed to the car axle. This is the form of the Edison epicyclic gearing[2] for street cars. In another form, with a train of gear-wheels, arranged on the epicyclic principle, one electric motor may suffice; but a clutch is necessary to bring about the slight variation in speed that is required to operate the epicyclic train. The Baldwin[3] epicyclic gear and friction clutch are developments of this form. The McQuesten gear employs a similar principle but with an electromagnetic clutch.

The epicyclic principle will be understood by referring to Fig. 1. This represents an ordinary epicyclic train of spur gear-wheels driven by electric motors. The motor armature M_1 and gear-wheel A are secured to a sleeve, loosely turning on shaft P P, such as a car axle; M_2 and D are also loosely sleeved on the same shaft. The gear-wheels B and C are keyed to the same shaft S S. The arm X, as a crank arm, is keyed to the shaft P P, but loosely mounted on shaft S S.

Three principal combinations of these three elements are possible. (1) Arm X, fixed; the motor M_1 will drive M_2 as a dynamo, or *vice versa;* the fields being held stationary. (2) Shaft P P held in fixed bearings, fields stationary, both motors M_1 and M_2 set in operation; the arm X will then turn around and carry the shaft S S and its wheels B and C around the shaft P P, when the motors revolve at different proportionate speeds. The arm X turns in a direction dependent upon the direction of rotation of the motors M_1 and M_2, and at a speed proportional to the speed of the motors and the number of teeth on the gear-wheels. When the four wheels, A, B, C and D, have the same number of teeth, and (*a*) the motors rotate at the same speed in the same direction, there will be no rotation of the arm X; (*b*) the motors rotate at different speeds in the same direction, the arm X rotates at a speed equal to half the difference of the motors' speeds. (3) Shaft S S held in fixed bearings, fields stationary, simply inverts the combination, and causes the secondary shaft S S to become now a primary shaft, while the former primary shaft P P becomes now the secondary shaft. Several minor combinations will suggest themselves; but the above serve to show the differential nature of the ordinary gear-wheel epicyclic train, when a *slight difference* of speed is produced at the driving wheels A and D.

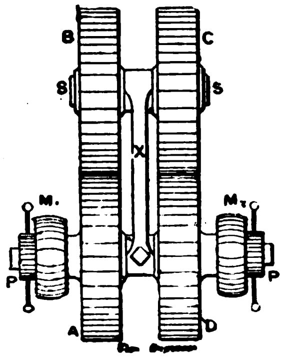


FIG. 1.—CONSTANT SPEED EPICYCLIC TRAIN.

The primary shaft P P may be driven forward or backward at different speeds, if the two motors are slightly varied in speed, and this requirement is the inherent defect of this form, where gear-wheels with constant velocity ratios are used. Of course, one motor at a constant speed may be used with a clutching device, but the combination is non-reversible. All speed variations are of necessity external to the epicyclic train itself.

The variable epicyclic train[4] was brought out by the writer, May 21, 1891, to obviate the objectional features of the constant-speed train, as above described. The principle is shown in Fig. 2. As long as the belt is normally central, there is no *tendency* for the arm X to rotate, as there is no lost speed to be made up. When the belt is shifted, there is an obvious tendency for the arm X to rotate in one direction or the other, according to which side the belt is shifted, and this results in the rotation of the shaft P P, to which the arm X is keyed, the constructive features remaining the same as in Fig. 1. In this combination, it is possible to obtain with a given shaft P P, a variable velocity, in either direction, from a shaft or motor moving at a constant velocity in one direction. Moreover, this change may easily be made continuous, without in any way interfering with the crank-arm X, from a maximum in one direction to a maximum in the other. Speed cones, pulleys, or other simple variable-speed gear may be introduced into one or both of the arms. All speed variations are internal in the arms of the epicyclic train itself.

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[1] *The Electrical World*, April 23, 1892; p. 274.

[2] THE ELECTRICAL ENGINEER, Sept. 17, 1 90, p. 303.

[3] THE ELECTRICAL ENGINEER, Oct. 22, 1890, p. 436.

[4] Submitted to the Committee on Science and Arts, Franklin Institute, Philadelphia; report made by the sub-committee Sept. 18, 1891, and adopted by the committee, Nov. 4, 1891.

Having arrived at the *variable epicyclic gear* by using well-known mechanical elements, as parts of the train of mechanism, it remained to develop the applications of the same principle by other modes of connection, such as by electromagnetic, hydraulic, and pneumatic means. The elastic nature of the medium employed in pneumatic connection is too unreliable for any definite variable-speed gear; but the characteristic features of the electromagnetic and hydraulic connection in mechanism render these of useful application.

The electromagnetic epicyclic[5] gear was brought out by the writer, Aug. 23, 1891. Gear wheels are replaced by constant speed dynamotors, cone pulleys, or speed cones, by variable-speed dynamotors; and these electromagnetic elements being substituted, as it were, in the epicyclic train, produce a constant or a variable speed epicyclic combination, useful for electric street cars, elevators, hoists, etc.

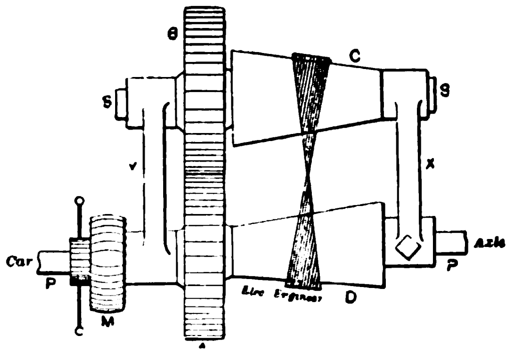

FIG. 2.—VARIABLE EPICYCLIC TRAIN.

The hydraulic epicyclic gear was developed by the writer, Sept. 1, 1891. It consists in the simple substitution of an hydraulic connection in the arms of an epicyclic train for the mechanical modes of connection heretofore employed. These hydraulic elements being thus substituted result in a constant or variable speed epicylic combination. Rotary pumps, turbines, or other hydraulic motors replace the dynamotors of the electromagnetic epicyclic, and the gear wheels and speed cones of the ordinary variable speed epicyclic gear. This hydraulic connection between the primary and secondary shafts, may be used for all purposes and with the usual advantages of the epicyclic combination.

As with the mechanical and electromagnetic devices already mentioned, the hydraulic epicyclic will produce variable rotation of a given shaft, in either direction, from one motor sleeved thereon, and driven at a constant speed in one direction. The hydraulic pump and motor, connected by an hydraulic circuit, in one or both arms of the epicyclic train, form a kinematical equivalent to the dynamotor combination. The hydraulic circuit, in this mode of connection, may be worked as a closed circuit, or open, and in connection with an air cushion or air chamber. The hydraulically connected motors in one or both arms of the epicyclic train, form "chamber gears" (Reuleaux), and perform all the functions of ordinary chamber-gear combinations,—whether as constant or variable-speed mechanical devices, or as ordinary rotary pump or turbine chamber-gear combinations, working with oil or water. The chamber gears here introduced in the arms of an epicyclic train, may be similar or dissimilar in construction, and equal or unequal chamber gears,—forming here "pressure-organs" (Reuleaux) which are kinematically equivalent to the simple constant or variable speed mechanical connections similarly used in the former cases.

As in the other two modes, the hydraulic connection may be internally or externally varied, in such a way as to change the speed relation of one or both of the train arms; or, to bring about a definite tendency to a change of speed between the primary and secondary shafts. This tendency to produce such a change of speed, is the peculiar feature of the *variable* epicyclic gear, and on which principle its chief merits rest. It is only an apparent tendency, for it is at once compensated for by producing a definite rotation of the arm X. Therefore, all of these varied modes of connection are but kinematical equivalents,—resulting in the same characteristic tendencies and capable of the same applications as variable speed epicyclic gears. The fundamental principle is equally developed in each of them, by a variable speed mode of connection, within the arm of the epicyclic train itself.

The question of rotating both the field and the armature arises at once in using the dynamotor as an electromagnetic connection in an epicyclic gear. In fact, it is upon this very principle that the successful operation of this form of the variable epicyclic gear depends. The matter has been considered at length, in this connection, when developing the electromagnetic "kinematic chain"[6] (Reuleaux). From the point of view of the kinematics of electromagnetic machinery, the armature and its field are elements forming an electromagnetic turning pair. As such an elementary combination, therefore, either may be rotated while the other is held stationary; or, both may be rotated at such proportionate speeds as shall cause the lines of force to be cut at the same rate as when one of them is held stationary. The same principle is applied in the Brackett cradle dynamometer, in which the field is freely pivoted, and the torque measured by a weighted lever or a spring balance. In this case, too, the mutual action of the field and armature is analogous to that considered, for the combinations of electromagnetic epicyclic mechanisms; for, if the field does not actually revolve at a given speed, there is a decided *tendency* for it to do so; and, this is all that is needed, whether in measuring the torque by a reacting spring-balance, or in causing rotation of the epicyclic train arm in the performance of useful work on the primary shaft. Lieut. Patten some time ago developed a form of double-rotation motor,[7] *i. e.*, one with revolving field and armature.

The efficiency of transmission in each of the three typical modes of connection in the variable epicyclic gear, will depend largely upon its design, construction and management. Mechanical devices have such a low efficiency as to more than offset, in almost all ordinary cases, the hoped-for gain in the motor efficiency. Electromagnetic and hydraulic connections should have almost the same efficiency, for the same number of transformations. In these, however, the efficiency of the epicyclic combination will be quite variable of itself, being affected by the same causes which now lower the efficiency of street car motors. The attention, however, which has been given to this question of intermediate gearing in many quarters, has evidently proceeded from a belief that some efficient form of gearing and efficient mode of connection could be devised and designed, which would strike a balance of a decided gain in the combined efficiency of the gearing and motor.

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[5] See paper before the Johns-Hopkins University Electric Club, Nov. 9, 1891, on "Electromagnetic Transmission of Energy," abstract published in the *Stevens Indicator*, January, 1892. Also, two papers before the Electrical Section of the Franklin Institute: "Notes on Electromagnetic Machinery,"—*Journal of the Franklin Institute*, February and March, 1892.

[6] First paper, "Notes on Electromagnetic Machinery," *Journal of the Franklin Institute*, February, 1892.

[7] *The Electrician*, (London), Dec. 16, 1887, p. 183.

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VOL. XIII. NEW YORK, JUNE 22, 1892. No. 216.

Perfection in every machine is a matter of development.—Coleman Sellers.

THE COMMERCIAL RATING OF INCANDESCENT LAMPS.

ELECTRIC lighting has given rise to not a few anomalies, but none, we think, are more difficult to explain than the differences which exist in the severity with which the purveyors and consumers of light look upon variations from standard candle-power as between arc and incandescent lamps. While the 2,000 c. p. arc lamp *nominal*, for the most part sends forth its rays nightly at a brilliancy probably not much exceeding 1,200 c. p. without calling forth more than an occasional grumble, the slightest falling off in candle-power in the incandescent lamp is sure to raise a howl of indignation from the consumer; and to his complaint is added that of the operating company, when the life of the lamp is unduly curtailed. Tests have often been made in order to ascertain the candle-power and life of incandescent lamps, and they go to show that in general an improvement in the efficiency of lamps as well as in life has been effected. Nevertheless, there are marked variations still to be found in the lamps of different manufacture, the reasons for which can be readily understood. The commercial rating of incandescent lamps, as is shown by Mr. Charles Wirt in this issue, is a very uncertain factor in determining the all-around qualities of a lamp, and he sums up very well by saying that the best lamp to buy is the one that gives the light needed for the least money—all expenses considered. Life and efficiency combined must determine the true value of a lamp, and Mr. Wirt's caution that the rating to be found on lamps should be carefuly checked by consumers is a very timely one. It might be argued by some that the small number of lamps of each kind tested by Mr. Wirt would scarcely allow of obtaining average results, but as far as they go they indicate the precautions which ought to be taken in order to obtain the best results in the employment of incandescent lamps.

RAILWAY ELECTRICITY.

THE meeting of the railway superintendents, held in Denver, Col., last week served to bring out strongly the intimate connection, in many ways, between the modern railway and the electric current. Beyond the now indispensable adjunct of the telegraph, the electric signal and many minor applications, railway managers are brought face to face with that larger and more important subject of electric traction, and it is well that Mr. Charles Selden drew the attention of his colleagues to matters which they may be called upon, at any time, to seriously consider in their daily work. The figures he gave as to the relative proportion of net profits to operating expenses of steam and electric roads were very significant as showing the greater remunerativeness of electric railways. To be sure, the traffic of both is somewhat different in its nature, but even to-day suburban roads, which are now barely paying expenses, as Mr. Selden pointed out, could be made profitable, and we are glad to learn that if the experiments about to be undertaken by the Baltimore & Ohio Road, at Baltimore, in the application of heavy locomotives to the hauling of their trains through the tunnel proves successful, it will be followed by the converting of the suburban steam road of the Baltimore & Lehigh Railroad into electric. The prospects and limitations of electric railroading on the standard-gauge roads as discussed from a mechanical and electrical standpoint in Mr. Frank J. Sprague's inaugural address, before the American Institute of Electrical Engineers, in Chicago, must be viewed with satisfaction by all electrical engineers interested in the progress of electric railroads, inasmuch as the conservative tone adopted by Mr. Sprague will serve to instill confidence in the minds of many who are prone to look upon the somewhat visionary schemes of some electrical promoters as the prevailing ideas of the general body of electric railway engineers.

DRAWING CHARACTERISTIC CURVES.

GRAPHICAL methods which present to the eye symbolized pictures of any given law of action are so convenient for study and comparison that their employment naturally suggests itself in all cases where they are applicable. In the case of the dynamo, especially, the study of the characteristic curve has done not a little towards its improvement, but, as Mr. R. S. Dobbie shows on another page, much of the value of such curves depends upon the selection of the proper scales for abscissæ and ordinates, respectively. An injudicious selection may frequently so distort the curve as to completely hide its true signification, while on the other hand a proper standard, not only brings out the true nature of the actions which the curve is intended to portray, but also allows of a direct comparison between different curves.

THEORETICAL ELEMENTS OF DYNAMO-ELECTRIC MACHINERY.—VII.[1]

BY

A. E. Kennelly

THE INFLUENCE OF IRON IN AND ON THE MAGNETIC CIRCUIT.

We have thus far confined our attention to magnetic circuits devoid of iron, circuits surrounding electric currents, and far removed from any of the magnetic metals. We have seen that in all such circuits, there will be a distribution of potential wherever there is a flux, except within the substance of the active conductors; that this potential and flux can always be determined by rule, however difficult the numerical calculation may happen to be, so that the elements of the circuits, such as we have defined them, namely M. M. F. (including potentials), flux, flux density, reluctance, and permeance, are all essentially determinate quantities, depending only on the strengths of the currents, and their geometrical arrangement. We now proceed to consider the effects of introducing iron into magnetic circuits. It will be seen that the changes thus effected are not fundamental but superstructural. The iron alters in no way the original system, but superposes upon it a new system, which the original one has induced, and these two, merged together, form a composite system whose resultant effects are presented to view.

The first evident effect following the introduction of iron into a circuit is an increase in the flux. In order to examine this under the simplest conditions, we will select that geometrical system which we know establishes a uniform intensity, and in a direction of uniform curvature—a closed circular solenoid—with a mean radius r and a small cross-sectional area a. Suppose this to be constructed of wood, and wound with Nc current turns. Then by the results of Chapters IV and VI we may consider that we have everywhere within the wood an intensity of $\frac{2\,Nc}{r}$, which we may call the prime intensity. Now suppose the wooden ring exchanged for one of iron having the same dimensions. We should find experimentally that the flux, and consequently the intensity, had everywhere increased in some ratio, μ, whose magnitude would depend on the quality of the iron, the value of the prime intensity, and the manner in which that prime intensity had been brought to bear upon the iron. But leaving these influences for later consideration, we should find that the flux had increased from F to $\mu\,F$. There would be no other magnetic change. Physically, of course, the magnetic structure and molecular condition of the iron must be different from those in wood, but so far as the magnetic circuit and its various elements are concerned, precisely the same effects would be produced within the wood, if the excitation on it had been increased from Nc to $\mu\,Nc$ current-turns. ($10\,Nc$ to $10\,\mu\,Nc$ ampere-turns.) There are only two ways in which the flux in this circuit can have been augmented by the substitution of iron. Either by an increase in the permeance, the M. M. F. remaining constant, or by an increase in M. M. F. with the prime permeance unchanged.

Here as well as in the corresponding case for the galvanic circuit, purely numerical considerations afford no choice between the two alternative hypotheses. The electrical resistance of a wire might just as well be considered as due to the effect of a counter E. M. F. produced in a definite relation to the current strength. All that we can observe is a fall of pressure along the wire, and this might be ascribed either to opposing E. M. F. e, or to its numerical equivalent $c\,r$. There are cases, such as that existing in the arc lamp, where the drop in pressure, largely due to counter E. M. F., was long ascribed entirely to resistance, and a distinction can only be effected in these instances by observing that the drop in pressure is not uniform in distance, or that residual E. M. F. survives the working current. For conductors in general, however, the principle of resistance is much simpler than that of its numerically equivalent counter E. M. F., and its practical advantage is decisive.

With the magnetic circuit of iron it is otherwise, for, assuming the change in flux to be due entirely to diminished reluctance, the reluctance of iron is not constant as is the resistance of metals in the galvanic circuit at uniform temperature, but varies with the conditions of the circuit; while on the other hand, it is found that after the current has been interrupted in the solenoid, a residual flux exists in the iron. If we are to retain the definition that M. M. F. and flux stand in the relation of cause and effect, it follows that there is residual M. M. F. in the iron. It is therefore more probable that the increase in flux is due to M. M. F. induced in the iron and coinciding with the prime M. M. F. in direction. Since the maintenance of flux does not imply expenditure of power, this does not violate any law connected with the conservation of energy.

According to these principles, the uniform prime intensity of flux in the solenoid, excites in the iron, when introduced, a uniform M. M. F. which will exist in every centimetre of iron under stress along the circuital path. Since the prime M. M. F. has increased μ times, the induced M. M. F. in the iron must be $\mu\,M - M = M\,(\mu - 1)$. Similarly the difference of potential primarily existing between any two planes drawn across the ring will have increased μ times as though the original P. D. of $\frac{2\,Nc}{r}$ per cm. had been increased by an induced P. D. of $\frac{2\,Nc}{r}\,(\mu - 1)$.

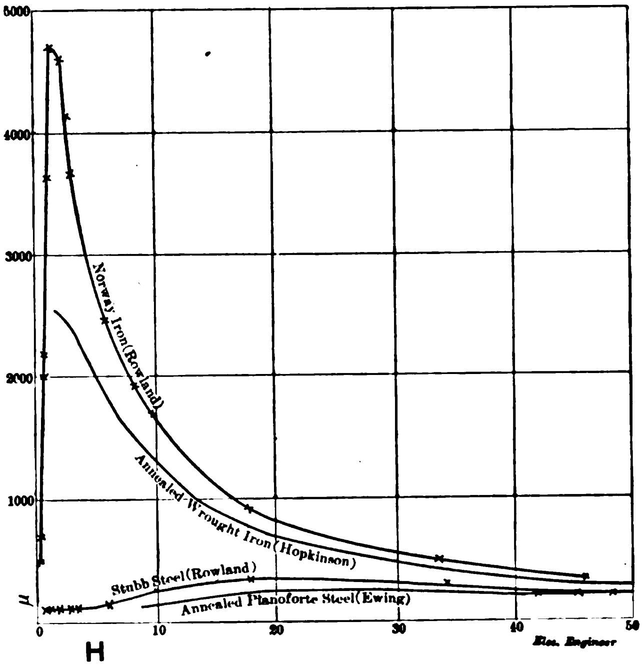

FIG. 15.

There are thus two complete and associated systems of P. D. flux, and intensity, in the iron ring. The first is the prime system that would exist if the ring were of non-magnetic material. The second is the induced system $\mu - 1$ times greater. On interrupting the current in the solenoid, and thus withdrawing the prime system, this induced M. M. F., flux and intensity remain. Strictly speaking the induced system does not remain complete, but suffers to a greater or less extent when the excitation is withdrawn, but under favorable conditions, as much as 95 per cent. may be conserved.

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[1] *Copyrighted 1892, by A. E. Kennelly.*

The numerical value of μ, the factor of augmentation due to the presence of iron depends upon the chemical and physical structure of the latter. For a given prime intensity, it is greater as the iron is softer and more nearly pure, while it is materially reduced by small degrees of impurity, especially when these consist of carbon or manganese. A value as high as 4,600[1] has been recorded for Norway iron in a particular case, and on the other hand a result as low as 1.85 has been reached under very exceptional conditions.[2] Fig. 15 gives some curves of values for μ with several qualities of iron. The abscissæ represent prime intensities, or the flux per square centimetre that would exist if the iron were removed and replaced by non-magnetic material. We know that this is the gradient of potential, and that in the circular solenoid it corresponds to the uniform fall of potential per centimetre of circuit. Prime intensity is commonly denoted by the symbol H. For example, in Norway iron, μ is seen to be 1,000 for about 16 C. G. S. lines per sq. cm. $(H = 16)$. If this particular intensity were produced in the interior of a closed circular solenoid, the complete introduction of Norway iron of this quality into the core would raise the intensity to 16,000 lines per sq. cm. and the P. D. per centimetre of circuit would be raised from 16 to 16,000 ergs per unit-pole. If the circumference of the ring were 200 cms., the exciting M. M. F. would have been 3,200, and the total M. M. F. after introducing the iron 3,200,000.

COMING DEVELOPMENT OF ELECTRIC RAILWAYS.—II.

BY FRANK J. SPRAGUE.

No one will question the capacity of a motor to do the necessary work required, or to make a speed superior to that of the steam locomotive provided sufficient energy be delivered to its terminals, but we must deal with existing or probable methods of supply. It is true that the speed at which a train is propelled by steam has only increased about 50 per cent. in 60 years, for in 1832 the "Matthew Baldwin" often made a speed of a mile in a minute; but we must not confound speed with power, for while the maximum speed has not been so materially increased, the endurance, the perfection of the mechanism, and the economy of performance have made great strides, and the increased speed, which is by no means the maximum possible of a locomotive *per se*, has been attained at much higher powers, and the schedule time has been shortened principally by cutting down grades, straightening curves, filling up ravines, abolishing trestle works, replacing wooden bridges by permanent ones of iron or stone; by the use of heavier and stiffer rails, better switches, improved methods of automatic signaling, the interlocking switch and signal system, and the abolition of grade crossings; in short, by improvements in details and management which permit of higher speeds on more extended sections of road because of greater safety, lower traction coefficients, and a greater degree of confidence possessed by the locomotive engineer.

All these things are necessary for high-speed electric railways, and any general improvements that will be of benefit to the latter must necessarily be of service to the former. Any predictions which are made concerning the future of electric propulsion, either in ignorance or disregard of the possibilities of steam duty, and the limitations necessarily existing in all systems of transportation, deserve, and will receive, little consideration. Hence, let us note a few recent locomotive performances.

Almost every one is familiar with the remarkable run recently made by a Schenectady locomotive hauling a special train on the New York Central Railroad, when the distance of 439½ miles from New York to Buffalo was made at an average speed of nearly 60 miles per hour, and which was the precursor of the Empire State Express, which makes the regular run at an average speed of over 52 miles. More recently, we have accounts of an interesting record, made by a well-known writer, on two runs between New York and Albany, on which a large number of indicator cards were taken. The weight of train was about 270 tons; the steam pressure varied from 160 to 170 pounds. From an inspection of about a dozen cards, the indicated horse power varied from 551 h. p. at 44 miles to 1,120 h. p. at 78.9 miles. At 60 miles per hour the train resistance is stated to have been 15 pounds per ton, and at 70 miles, 17.10 pounds per ton. About seven pounds of water were evaporated per pound of coal. A remarkable statement concerning this performance was made by Mr.
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those who
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whole trip shows
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expenditure of only
per h. p. per
hour. This is far better than many stationary engines. On the New Jersey Central Road one schedule time is 86¼ miles in 89 minutes, which is made where there are a number of necessary slackings. On the 13th of May the time was taken of the speed of a Baldwin compound locomotive for a considerable period of time on one of the regular runs. Ten continuous miles were made in 452½ seconds and five were made in 222 seconds. The fastest time taken was 44 seconds, and the slowest noted was 47.

On the 26th of last February a similar compound passenger locomotive running on the same road broke all steam records by running a mile in 39¼ seconds, or at the rate of nearly 92 miles per hour. At this speed the indicator cards showed 930 h. p., and the drivers, which are 78 inches in diameter, were making 395 revolutions per minute.

In the very near future, I expect to have the pleasure of riding on a locomotive when going at these high speeds, and I presume my respect for steam locomotion will not be diminished thereby, nor, on the other hand, will my confidence in the possibilities of electric propulsion, under the proper conditions.

Experimental runs have been made with an electric locomotive at the rate of a mile in 30 seconds, that is, 120 miles an hour, and I confidently expect some day to go at that rate. But it will be under special conditions and not on the regular trunk lines of this country, and it is the height of folly to suggest that these steam trunk lines are to be abolished.

In making these very high-speed runs there is not much attempt at maximum economy of coal consumption, the necessity being to generate steam as fast as required by the cylinders; but on taking an average of five trips, I find that there was evaporated 7.19 pounds of water per pound of coal used and 9.41 pounds of water evaporated per pound of coal consumed. The total weight of train varied from 218 to 241 tons. The personal equations of engineer and fireman necessarily enter seriously into steam operations, and this, compounded of course with the peculiarities of each engine and the conditions of service, is shown in railroad reports.

In this connection, I recently inspected a number of engine sheets. On one, which gave the duty of 25 engines, the average total cost per engine mile was 10.85 cents, of which 2.66 was for fuel. The total cost varied from 6.8 to 19.24 cents, and the fuel (wood) from 1.96 to 4.77 cents. On another sheet giving the performance of 22 engines, the total cost per engine mile was 14.70 cents, of which the fuel cost 4.61. The total cost varied from 8.82 to 27.98 cents, and the fuel cost from 2.04 to 7.48.

In still another, that of the performance of 18 engines, the total cost per engine mile was 14.73 cents, of which the fuel (coal) cost 6.62 cents. The total cost varied from 10.04 to 22.52 cents and the fuel cost from 3.83 to 13.84 cents.

In discussing the electric system there is often a confusion of statements with reference to economy. Despite the undoubted fact that the electric motor can probably be run at variable high speeds with less variation of economy than can the steam locomotive, we must not forget that in the latter we are considering the economy of the unit as a whole, not merely of the steam cylinders, but also of the boiler and the furnace. In electric propulsion a similar comparison of economies must take into account the variable duty of the central station and the losses on the line as well as those in the motor, and where single units are used the variation in economy of the whole system would be much greater than in the steam locomotive. There will be only a reasonable fixed efficiency of the central station and the line when the number of units is large enough to make the load on the central stations nearly constant.

Let us now consider another class of duty. Some time ago I made a very careful analysis of the work done on the elevated roads in New York City with a view of determining the coal consumption and the duty performed by the locomotives. At the time this investigation was made, now nearly seven years ago, there were in use on the Third avenue division, 68 trains at one time, running at very close intervals. The weight of the trains was from 80 to 90 tons; the speed was often as high as 20 to 25 miles an hour; stops were made every third of a mile; in short, the duty demanded of the engines was exceedingly severe.

The maximum indicated horse power of the locomotives was found to average about 163 h. p., although on occasions these locomotives have been worked up to 185 h. p. Work was divided approximately as follows: Acceleration in starting 59 per cent., lifting 24.3 per cent., and traction, 16.7 per cent. The average horse power exerted was 70.3 h. p., considerably less than one-half of the maximum.

The work on the line was so distributed that there was an almost constant total duty of about 4,500 h. p. The locomotives were on duty 20 hours, but used steam only six hours, and, including all losses when standing still, together with the amount

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[1] Rowland. Phil., May, 1873.

[2] Ewing, "Magnetism in Iron," p. 139.

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between steam and ele be about in a ratio of two to one, but if the energy of the train was returned to the line to the extent which I believe it is possible, then the relative expenditures of fuel would be in the proportion of seven to two. Since the coal charge on the four divisions was at that time about $550,000, it can easily be seen, that independent of any question of saving in the care of the structure and any reduction or depreciation of the motor equipment, the fuel saving wonld be sufficient to pay a good interest on the cost of an electric equipment, and a large interest on the cost of electric equipment, minus the value of the present engines. I have no reason to doubt the soundness of the conclusions I then made.

You will have here in Chicago, however, a somewhat more advanced condition of affairs. A compound type of locomotive has been adopted for the elevated road service, and I believe it will show an increased economy over that of the operation of the New York roads. Consequently, in discussing the question of economy, it is necessary to get full information concerning the duty which will be done here.

In discussing high speed possibilities and limitations, the testimony of Dr. Dudley as given in a discussion of a paper before this Institute on the 24th of February, 1891, is interesting. There are, generally speaking, three distinct elements constituting the resistance to train movement on a level, and they have a most important bearing when we consider the operation of long or short trains and at high speeds. One of these elements is the friction of the train in its bearings; with good rolling stock this is about eight pounds per ton. For all reasonable speeds it is probably fairly constant, provided the lubrication is good. Another element is that of air resistance which varies with the shape of the forward end of the train, the condition of the air, the direction of the wind, and the velocity of movement. The third I may call the train lifting or rail bending effort, which depends upon the weight and stiffness of the rails and solidity of the road bed.

Dr. Dudley stated that on the New York Central system he found that trains of about 250 tons when running at a speed of a mile a minute, have a resistance of from 10 to 12 lbs. per ton, but that on short trains of two or three cars the resistance sometimes ran as high as 35 or 40 lbs. per ton. This is probably due not to any change in the friction of the bearings, but to the fact that the air resistance enters as a much higher component of the total.

It at once emphasizes the fact that the operation of short trains at high speeds must, no matter how good the track or how favorable all other circumstances, be with a train resistance higher than that required by long and well-vestibuled trains. Such a shape can be given to the front of an electric locomotive as will make the air resistance not over one-half that presented by a plain surface of equal cross-section and perpendicular to the line of motion, but even this fact does not alter the other, that the resistance per ton must be higher for small trains than for large ones.

Mr. Dudley further stated, in speaking of the influence of stiff rails, that the difference in power required on the Chicago Limited when running on an 80 and a 65 pound rail was from 75 to 100 h. p., that is, somewhere between 10 to 12 per cent. of the power actually developed, and he estimates that with a 105 lb. rail which is nearly twice as stiff as the 80 lb. rail there would probably be saved another hundred horse power, making a total saving of a quarter by less than doubling the weight of the rail. In his opinion it is perfectly safe to run a steam engine 120 miles an hour on this heavy rail.

Such rail improvements increase speed possibilities with present engines, but we have not reached the limit of steam duty. Almost all the locomotive work of the United States has been done up to the present with simple engines. Their weight and capacity have been increased, their steam pressure raised until the standard is now about 140 lbs. Within recent years, however, the compound locomotive has come into use, and there is a comparatively large number of them in daily service. The steam pressure has gone up to 180 lbs. as a standard, working sometimes as high as 200 lbs.; but these are by no means the limits of steam pressure. On the Paris, Lyons and Mediterranean Railway, the standard for steam pressure for compound locomotives is 250 lbs. The compound locomotive has still its battle to fight, but I think he would be a rash man who will say that the days of still higher steam pressure are not to come, and that the triple-expansion locomotive will never exist.

Speed, capacity and coal economy are, however, not the only questions to be considered in railroad operation, and in discussing the general subject it will be found that the signaling and braking questions at high speeds are serious ones. Undoubtedly an electric train with distributed motors, making the weight of the train available for traction, could, by using the motors as dyanmos, return the energy of the train to the line from the highest to mean speeds and then on a local circuit be more quickly and effectually slowed down and stopped than where shoe brakes are used, and both methods of course would be available. But if using a motor ahead of a train then there will be comparatively little difference in the stopping power.

When riding at 60 or 70 miles an hour, it is a very quick stop to bring a train at rest in less than 2,000 feet. This is often as far as any signal can be made out, especially when the weather is at all thick. Hence we may expect to find on electric railroads, if high speeds are to be attained, and quite possibly also on steam railroads, an extension of automatic signaling so that trains indicate on more than two sets of signals. At present the practice is to divide the line into sections, and when a train passes a certain point it sets a danger and a cautionary signal, dropping the danger signal on the section just preceding, and the cautionary signal on the one beyond.

Turning now to the greater powers, we must not confuse the terms "large powered" and "trunk line" work. There are two statements which I think will need no corroboration. If we had a continuous train movement completely occupying a track system, there can be no question but that its operation from a central source by electricity would be more economical than if operated by steam locomotives. So too, if a large number of units in reasonable proximity are moved, and the stopping and starting so regulated that the total demand upon the central stations is fairly continuous and equal, then there is no question as to the economy of electric propulsion as compared with steam.

On the other hand, the operation of a single or very few units over a long distance would be so uneconomical and afford so small a return on the invesment required as to make it prohibitory. Between these two lies the condition of operation where steam and electricity meet on planes of equality; as the number of trains decreases, steam operation is the more economical; as the number increases electricity must be preferred.

In discussing the use of electricity instead of steam, a well-known steam engineer recently stated that in his judgment it must be conceded that electromotive force for the propulsion of cars will not be economical except for suburban traffic and upon certain sections of important trunk lines like the New York Central between New York and Albany, the Pennsylania system between New York and Philadelphia, the other lines of like character where it is necessary to dispatch a large number of comparatively light trains every day, and at short intervals. The principal field for a power of this kind would be in suburban service long enough to make the ordinary street electric cars unpopular because of the time required, and in such cases as those mentioned above; also for moving freight trains in cities, that is, for the performance of transfer service. This is precisely in line with the arguments I have advanced from time to time, and which I illustrated in a paper before the National Electric Light Association at its Convention in Kansas City, where I outlined the possible service between New York and Philadelphia, which I believed to be practicable, and to which I will again refer.

I must repeat that it narrows itself down to the one question as to the number of trains operated between two terminal points. Make that number of trains sufficiently large, and the electric motor is the best means of propulsion, whether for high or low speed, whether for large or for small cars. Decrease this number and we must rely on steam propulsion; or to put it in another way, the answer to the query, Will electricity take the place of steam for railroad purpose? is: Only in part, and then only when the number of units operated between the terminal points is so large that the fuel economy would pay a reasonable interest and depreciation of the necessary cost of the central station and the system of conductors.

Of course I do not in this general reply consider those special cases where advantages are to be gained for which there is a return for capital in another direction. Such a case is that of the Baltimore Tunnel, where the investment and cost of operation will be greater than that for steam propulsion; in fact, there will practically be no economy in power because the steam locomotives are not done away with but simply unused for a period of a little over a mile. There is in this specific case, however, the incidental advantage of doing away with the necessity of a ventilating plant and yet getting rid of the annoyances incidental to tunnel service. Trunk line transportation being a great problem, we should not attempt the simultaneous solutions of all the questions involved, but instead, determine what those questions are, consider their sequence, and the probability of success and solve them in their order.

A CORRECTION.

In the article entitled "The Economy of Condensing Engines Overrated," by Mr. J. H. Babcock in our issue of June 1, a misprint made the last paragraph but one read incorrectly. It should have read as follows:

"The case is simply this: Given a certain amount of fuel to be burned under a battery of boilers which produces in steam a certain number of heat units. The best we can do in engine work leaves more than 80 per cent. of these units still in the steam after it has passed the engines, and which escapes in the water from the condenser if one be in use."

Legal Notes.

THE EDISON INCANDESCENT LAMP PATENT—FINAL HEARING BEFORE THE U. S. CIRCUIT COURT OF APPEALS—III.

REFERRING next to an affidavit made by Mr. Edison in a certain proceeding in Canada in reference to this invention, General Duncan contended that Mr. Edison had regarded "purely structural carbon" as the only kind available for his use. This was the high resistance carbon of the patent; it was one of the things he had had in mind when he used that undefined term "filament"; it was the thing which he had said in his affidavit was the chief element of his success. But the defendant's lamps had been made by a process of hydrocarbon treatment; they had been shaped either from paper or from tamidine and then carbonized, and afterwards subjected to a hydrocarbon treatment by which mineral carbon had been deposited in their pores and their resistance reduced from 50 to 90 per cent. Was that the kind of carbon which Mr. Edison had said was absolutely essential to the making of an incandescent lamp? He had discovered, as he says, that only a purely structural carbon could be used, unmodified by any treatment tending to fill its pores with unstructural carbon to increase its density or to alter its resistance. Was there any special reason in the prior art for Mr. Edison to impose such a limitation upon this new thing? In 1887 Fontaine had tried certain experiments with the Konn lamps, but he found the carbons went to pieces, and he had about reached the conclusion that carbon was an unserviceable material for incandescent lamps. The following year Sawyer and Man invented that beautiful process of theirs, the hydrocarbon treatment, whereby imperfect carbons could be made of uniform structure throughout, as well as another extremely valuable invention in the manufacture of carbons; a method of more effectually disassociating the carbon from oxygen. They had made a large number of lamps in 1878, embodying those two inventions, which became the subject of patents in 1878 and 1879, and being thus patented, they were not open to Mr. Edison, but he had, nevertheless, devised his own method of working; a method of carbonizing; a secret one as appeared from the testimony, not revealed at the time and not revealed even at the present time. His new method of carbonization, according to his general account of it, left the carbon in that condition of porosity in which it came out of the muffle. He especially disavows any suggestion of a process which would deposit unstructural carbon in the pores. Defendants therefore thought they had a right to insist that the term "filament" imported this condition, and that it was by reason of the high specific resistance of the burner, due to that kind of carbon that Mr. Edison was able to secure the high total resistance which he says is essential to the use of a large number of lamps in multiple arc.

In dealing with the question of coiling the burner, Gen. Duncan said that he had omitted to consider one passage in the specification, which had been much relied on by the plaintiff in support of the proposition that it was not necessary to coil the burner. Mr. Edison had said, "I have carbonized and used cotton and linen thread, wood-splints, paper coiled in various ways; also lampblack, plumbago and carbon in various forms mixed with tar and kneaded so that the same may be rolled out into wire of various length and diameter." But he (Gen. Duncan) thought that the subsequent paragraph, dealing with the question of the distortion of the filament while being carbonized, showed conclusively that Mr. Edison did intend, under all circumstances, to coil the carbon. It went without saying that these limitations sought by defendant to be imposed upon the second claim were not accepted by the plaintiff. It was absolutely essential to the success of their contention that those limitations should be removed from the patent. The defendant did not coil its burners, two of its carbons were below 100 ohms resistance, and it made use, moreover, of a carbon treated by hydrocarbon process and having its resistance greatly reduced thereby. He thought that contention was out of all harmony with the views expressed by Mr. Edison, by the plaintiff, the Edison Company, and by their respective counsel, when they were urging before the Patent Office, from December, 1880, down to 1887, the divisional application for a patent applied for in December, 1880. The only difference between one of the claims of this divisonal application and the second claim of the patent in suit, as interpreted by the plaintiff, was that the word "flexible" had been introduced into the claim of the application; but this was mere surplusage, for it was in evidence and had been insisted upon by all plaintiff's experts, that flexibility was an inherent condition of a carbon filament. They had been informed in the court below by counsel that this divisional application had been permitted to lapse. For a long time they had been trying to ride two horses, but the courses of the two animals had become so widely divergent, that they had been compelled to leave one and rest their case on the other. They had chosen now to come into court and say that the patent in suit was for putting an incandescing carbon filament into an all-glass globe from which the air had been exhausted, but for years they had insisted in the Patent Office that no such construction was possible for the patent in suit. Which was the better judgment of those gentlemen? That first expressed, when they thought they could secure a patent that in terms would cover the very ground they desired to cover, or the interpretation which had been picked up as a forlorn hope, and on the possible chance of success presented to this court?

There was another aspect of that divisional application which defendants desired to urge upon the attention of the court.

It afforded an adequate explanation of the long delay of the plaintiff to bring suit against the United States Electric Lighting Company. They had no faith that the patent in suit could be interpreted to hold the defendant's lamps, but they had hoped that they might, on the pending application, secure a patent which would hold defendant's lamps to be an infringement, and failing in this they had said: "Now the only chance we have is to go to the court and seek to put upon patent No. 223,898 an interpretation which we have disavowed over and over again before the Commissioner of Patents." In the Circuit Court the reference to this divisional application had been brief. The court had said: "It is of but little import what Mr. Edison or his solicitor may have thought about the meaning of the claims during the pendency of the application for a subsequent patent. There are many adjudicated cases where the inventor builded better than he knew; where a patent has been sustained for an invention, the full significance of which was not appreciated by the inventor when he made it." It did not seem to him that that quite met the case. The question was not whether Mr. Edison had foreseen all the uses of his incandescent lamp, but what had he understood his invention to be? To answer this, resort must necessarily be had to the utterances of the inventor; primarily they were, of course, to go to the patent. If the inventor had failed to make a complete disclosure of his invention, then they had a right to take his other contemporaneous utterances, and when they had gone to this divisional application of Mr. Edison, they found, that year after year language had been used that was wholly at variance with the construction now insisted upon by the plaintiff.

General Duncan said he would next turn to the consideration of the prior state of the art. It was logical to determine so far as practicable the exact date of the invention of the patent in suit. He contended that this date could not be earlier than October 21st, 1879. The patent seemed to claim that Mr. Edison's invention consisted largely in the use of a peculiar form of carbon to which he had given the curious name of "filament." Long before that date many things had been done in the art of electric lighting and in the kindred arts, to which it seemed profitable to call the attention of the court. One of these notable things was the Geissler tube. It showed the use of a globe made entirely of glass and highly exhausted, and also means for conveying an electric current into the vacuum, consisting in the use of fine platinum wires sealed by fusion. It also showed that where an increase of resistance was desired for securing a larger amount of light, it could be done by diminishing the cross-section and increasing the length, and by coiling the increased length in a spiral. Another important contribution was the radiometer of Professor Crookes, consisting of a glass globe hermetically sealed at all points, into which had been introduced a spiral of fine platinum supplied with an electric current by means of platinum wires sealed into the glass by fusion. It was in every sense of the word an electric lamp, although it had not been employed for the general purpose of illumination; that was not the problem Crookes had been aiming to solve. They had repeatedly been told by gentlemen on the other side, that the very essence of a filament was a high ratio between resistance and radiating surface. If that be so, then the British patent of King of 1845, which had instructed a person to take a very small pencil of carbon rather than a large one, had given instruction to select the form of carbon that would give a relatively high relation of resistance to radiating surface. He did not think his friends on the other side had the right definition of a filament, but if they were right, then the whole philosophy of the filament had been revealed in the King lamp. He would next consider for a moment certain patents granted to Mr. Edison in France in 1879 and in this country in May, 1880, upon an application filed in April, 1879. They were upon Mr. Edison's platinum lamp. As this invention had played a very important part in the general discussion, he trusted that it would receive full consideration from the court at the final discussion. In those patents he had said that in order to use a large number of lamps in multiple arc, the resistance must be very high, and that this could be secured by a small cross-section of wire of great length, and in order to use this great length he had coiled it up on a bobbin. The lamp was essentially like the lamp of the patent, except that in one case platinum is used for the burner and in the other case carbon. In both cases they had the all-glass globe, the high exhaustion and the fine platinum wires for carrying the currents into the interior of the globe through the walls. In April, 1879, Edison had applied to the Patent Office for a patent upon his platinum lamp. He did not obtain it until May, 1880, and then with a very broad claim, more comprehensive than any claim in the patent in suit, even under the interpretation insisted upon by the plaintiff. If Mr. Edison had created a revolution in the art, or a new art, which of these patents had accomplished that result? Was it this patent of manifestly narrow limitation, in which *coiling* was embodied as a necessary element, or was it this broader patent on the platinum lamp, wherein he had described, with greater fullness than in the patent in suit, the advantages of high resistance and small radiating surface; of a globe all glass and highly exhausted, and had then taken a claim acknowledged by their adversaries to be more comprehensive than any claim of the patent in suit?

In a caveat which Mr. Edison had filed in the Patent Office in 1879, during the pendency of the application for the patent in suit, he had said: "The object of this invention is to produce carbon conductors of high resistance to produce the electric light by incandescence." He then tells us that if he takes retort carbon, and pulverizes it, and mixes it with non-conducting substances, and molds it into the form of a burner, that burner will be a "carbon conductor." Now that was precisely what Lane-Fox had described in his British patent, published before the date of Mr. Edison's invention of the thing covered by the patent in suit. Lane-Fox had made a burner of that description, of small cross-section, having a high resistance, and enclosed in an all-glass globe from which all gases capable of attacking the carbon had been excluded.

After referring at considerable length to the work done by Sawyer and Man and the experiments of Dr. Adams, of Boston, General Duncan said that defendants felt justified in contending that at the date when Mr. Edison professed to have made the invention of the patent in suit, October 21, 1879, it could not have been patentable to anybody to employ carbon for making an incandescent lamp; to use a high vacuum to protect the carbon from destruction; to use a globe entirely of glass for preserving a high vacuum, nor to make use of leading-in wires of platinum sealed into the glass. It was perfectly well known, moreover, that lamps must be arranged in multiple arc in order to secure a wide distribution, and that to secure that result the burners must be of high resistance and small cross-section. It was perfectly well known too that when two pieces of glass were sealed together with cement and the vacuum deteriorated, the remedy was to fuse the glass together. It was not competent at that time for Mr. Edison to claim an electric lamp having as a burner a continuous conductor in an exhausted glass enclosing globe. He also contended that it was not open to Mr. Edison on October 21, 1879, to claim an electric lamp having a continuous carbon conductor reduced to filamentary size, and introduced into an all-glass and exhausted globe. That was simply the question of putting one piece of carbon in place of another piece of carbon, or of putting a piece of carbon in place of platinum. The best testimony which supported that proposition had been Mr. Edison's own statement, which was in evidence. It was simply a question of the substitution of material. Mr. Edison's doubt was not whether carbon substituted for platinum would remain sufficiently stable for commercial purposes. It was whether he could make a filament of carbon sufficiently homogeneous. There lay the difficulty; there was the field for invention. He had solved that problem, partially by a compromise. He could not get down to a sufficiently small cross-section, and therefore had been obliged to content himself with a larger cross-section, and then to get the requisite resistance he had taken a longer length of the larger size and had disposed of the surplus radiating surface by coiling up the extra length.

It would be interesting if time permitted, to examine the testimony of Mr. Edison and his coadjutors as to the utility of the several materials named in the patent from which to construct a burner. Their testimony had completely refuted the proposition that any invention disclosed in the patent could have had any favorable effect upon the art. He thought Judge Wallace had been in error in holding, as he had done in his opinion, that lamps would and did succeed which were made solely under the patent in suit.

There were grave criticisms which might be passed on the patent in suit on the score of its ambiguity. It went without saying, upon a simple inspection of the patent, that the emphasis of the second claim lay in the presence of the term "filament"; a term which ought to have been defined, but which had been left in such a condition that it was impossible to know what was meant. General Duncan then quoted at length from the decisions of Judge Wallace, of Lord Frye of the English Court, and of the German Court of Appeal, severely criticising the ambiguity and the uncertainty of the language of the patent. He contended further that the description was not so complete, clear and exact as to enable any one to make a practical lamp. Prof. Thomson, who has had large experience, had said that one could not, by following the description of the patent, and without resort to other processes and inventions not known to the art at the date of the patent, make a practical lamp, and had given his reasons in full. Then Mr. Howell had been called by the plaintiff, and had said that he had made lamps without any difficulty, and had told how he did it, and it had proved that Mr. Howell had resorted to a method of carbonization not known to the art at the date of the patent. He had found it necessary indeed, to use the very method of carbonization which Mr. Edison in January, 1880, had been working in secret, and had not revealed in the specification now before the court. In other words, the Edison Company when they had been put to the crucial test as to whether or not the description in this patent was sufficient, had come into court and had confessed that they could make good lamps under this patent, if permitted to employ methods of carbonization not known to the art at the date when the patent issued.

"PARENT" COMPANIES AND LIGHTING COMPANIES—KANSAS CITY ELECTRIC LIGHT CO. vs. THOMSON-HOUSTON ELECTRIC CO. ET AL.

THE petition of plaintiff, filed in the Circuit Court of Jackson county, Missouri, June 7, 1892, sets forth, that under and by virtue of a certain contract entered into on the 14th day of Nov., 1881, by and between the American Electric Company, predecessor of the Thomson-Houston Electric Co., party of the first part, and J. S. Chick, trustee for J. W. L. Slavens, *et al.*, predecessors of the Kansas City Electric Light Co., party of the second part, said first party licensed said second party for the sole and exclusive use in the counties of Jackson, Missouri, and Wyandot, Kansas, of all apparatus manufactured or controlled by virtue of the patents then owned or controlled, or *to be* acquired, owned or controlled by the party of the first part. The petition recites that one of the most valuable patents thereby conveyed was that covering the device known as the "Thomson Automatic Regulator," and that notwithstanding its obligations under said contract to sell said device as well as all other apparatus in said counties only to or through the party of the second part, the Thomson-Houston Electric Company did license the Fort Wayne Electric Company to manufacture under said regulator patent, and that the Fort Wayne Electric Company, upon the authority so given, sold to the American Electric Light Company, of Kansas City, a plant of six hundred arc lamps equipped with said regulator. On account of this breach of contract, the plaintiff asks the court to enter judgment in its behalf against the defendants for damages aggregating $210,000, to decree that an account be taken of losses and damages sustained by plaintiff by reason of the premises; that said American Electric Light Company of Kansas City, be restrained from using said regulator in said counties; that the defendants, the Thomson-Houston Electric Company *et al.*, be forever restrained and enjoined from selling any of their machines with said regulator attached in said counties to any person or corporation excepting plaintiff; that said American Electric Light Company, of Kansas City, be enjoined from purchasing said regulators, and that the plaintiff have any other and further relief to which in equity and good conscience it may be entitled.

The progress and result of this suit will be noticed with great interest by many lighting companies who will be glad to learn what degree of protection they possess in the use of patented devices purchased under contracts similar to that sued upon by the Kansas City Electric Light Company.

GILLETT vs. WESTERN UNION TELEGRAPH CO.—CONTROL OF TELEPHONE PATENTS.

THE suit of Gillett *et al.* vs. the American Union Telegraph Company, came up for trial on Thursday last before Judge Wallace and a jury in the United States Court in this city. In 1880, Webster Gillett, one of the plaintiffs, sold a controlling interest in a patent for a long-distance telephone transmitter to the defendant company, under a contract stipulating that neither party should sell its interest without the consent of the other, and that the defendant company should use its best endeavors to establish a profitable business in making and selling the patented telephones, paying to the complainiant a stipulated royalty on each instrument. The defendant company afterwards transferred all its property and franchises to the Western Union Company and as plaintiff alleged, thereby placed itself in a position whereby, by reason of the existing contracts between the Western Union and American Bell Companies, it became totally incapacitated from carrying out its contract with the plaintiffs. Damages of $100,000 were alleged to have been sustained by reason of this alleged breach of contract. After hearing plaintiff's evidence, Judge Wallace decided that no title in the patent had passed to the Western Union Company, by virtue of the consolidation proceedings, and that plaintiffs had failed to make sufficient affirmative proof that any actual damages had been sustained, and he directed the jury to bring in a verdict for plaintiff of six cents damages.

THE OLD WESTERN UNION—AMERICAN BELL SUIT.

A SPECIAL dispatch of June 2, from Boston says: "A $12,000,000 suit was dropped from the United States Circuit Court to-day, but it was done in such a manner that it can be renewed at any time. It was the suit of the Western Union Telegraph Company against the American Bell Telephone Company for alleged breach of contract. The suit was brought to compel the defendant to transfer to the plaintiff one-fifth of the shares of the capital stock of numerous corporations operating telephones and exchanges throughout the United States, and also one-fifth of the dividends of the companies and one-fifth of the sums paid the defendants for license to connect telephone exchanges, and one-fifth of the bonds and securities received for the licenses for telephones. The gross amount claimed by the telegraph company is about $12,000,000. The contract which forms the basis of the suit was made Nov. 10, 1879, between the American Speaking Telephone Company, the Gold and Stock Telegraph Company, the Harmonic Telegraph Company, the Western Union Telegraph Company who are the present plaintiffs, and the National Bell Telephone Company, which was the predecessor of the present defendant. The Western Union Company controls the stock of the companies named as plaintiffs, except the Harmonic, and the contract was an agreement which was intended to settle a war between the telephone companies, and also settle the titles of the parties.

The contract gave the defendant the right to conduct the general business of the telephone companies, and a right to use the Gray and Edison patents, which were owned by the plaintiffs. By the contract the defendant was to pay the plaintiffs 20 per cent. of all sums received for rentals and royalties. The question raised in the case was whether the 20 per cent. was to be returned upon all sums received or only on profits made."

Letters to the Editor.

STORAGE BATTERIES IN PARIS CENTRAL STATIONS.

In the May 18 number of your estimable journal we read under the caption "Storage Batteries in Central Stations in Paris," a long dissertation in favor of the accumulators made by the Société pour le Travail Electrique des Metaux. According to this article they are the only ones used both in central stations and in various private installations near Paris. The self-confidence of the author of this article is surprising. Permit me to give the facts in the case.

We will not dwell on details owing to the fact that the suits which we have brought against all the infringers of the patents of Faure-Sellon-Volckmar are now on trial before the Correctional Court of the Seine, and we consider the Société pour le Travail Electrique des Metaux one of our worst infringers.

Competing with the accumulators of this last-named Société, we have our makes installed in the stations of the Société Popp. Moreover, we inform you—and this has much weight in judging the satisfaction which our products give—that M. Popp has just asked us for and obtained a license to make them.

Besides, several very important companies and firms of Paris and France have also negotiated for licenses from our company, notably "La Société Electrique à Bruxelles" (Julien), "La Société Betts & Cie, of Carcassone, la Société des Accumulateurs Tommasi, de l'Atlas, Tudor, the firm of Jarriant, in a word, all the houses which do a good commercial business. These attestations place strong doubts upon the truth of the information furnished your esteemed contributor during his stay in Paris.

As to the assertion that the accumulators of the Société pour le Travail Electrique des Metaux, having shown an efficiency of 90 per cent. in the tests made by the French Government, it comes from interested parties. Nothing has been published officially in regard to this matter, but we can tell you that it comes to us from an official and absolutely disinterested source that they do not bear any comparison with the Faure-Julien type of accumulators.

The electric traction which has been accomplished by us with success upon many of the street car lines of Paris, still awaits its practical realization by the Société du Travail Electrique des Metaux, who are still at it in Paris, after an attempt of three months without turning out a single vehicle to the public. We consider, sir, that you will be too anxious for the truth not to grant us space to rectify what we should have liked to explain at length.

THE AUTHORIZED MANAGER,
Société Francaise d'Accumulateurs Electriques
"Faure-Sellon-Volckmar."

PARIS, June 2, 1892.

STORAGE BATTERIES IN PARIS CENTRAL STATIONS.

With regard to the letter from the Société Francaise d'Accumulateurs Electriques "Faure-Sellon-Volckmar" of Paris, I would state that it was not my intention to imply in my contribution to your journal of May 18th, on the subject of "Storage Batteries in Central Station Work," that the accumulators of the Société Anonyme pour le Travail Electrique des Metaux as described by me were the *only* accumulators in use in Paris. My object was to state as briefly as possible a few interesting facts regarding a system which is being worked successfully on a very extensive scale and, as far as I could learn, more extensively than any other system in Paris. At all the stations of the Société Popp, I saw only cells of the large type as described. I was informed that they had a few of another type which, however, were being rapidly replaced by those of the Société Anonyme. It would have been very interesting to know how many and what sized cells of the Faure-Sellon-Volckmar pattern are now being used by the Société Popp and also in other parts of Paris. The fact that certain companies have *asked for* manufacturing licenses does not appear to me to effect the main object, namely, that of actual successful results obtained from the practical working of large cells on a large scale, such as is demonstrated by those of the Société Anonyme pour le Travail Electrique des Metaux. If the Société Francaise d'Accumulateurs Electriques Faure-Sellon-Volckmar have at the present time installations on an equally extensive scale and working with equally or more successful results, I can only state that any particulars as regards these practical results would be read with the greatest interest by readers of your journal, myself included.

As regards the ninety per cent. efficiency obtained by Government tests at Toulon, I have this statement over the signature of a responsible authority. Over the same signature I have the statement that the cells of the Société Anonyme, etc., have lately been selected after repeated trials in preference to all other types on a tram car line in Paris. I have every reason to believe the type of cell as manufactured by the Société Anonyme, etc., in Paris, has not fallen out of favor since my visit, from a letter, lately received in answer to some inquiries, wherein it is stated the output at the works at St. Ouen has considerably increased of late.

Now, as regards the questions of patent litigations, this is the chronic disease of every accumulator company which has ever done any business and is also outside the present question, namely, actual working results on a large practical scale. Apart from the patent-right question (which let us all sincerely hope will be decided before the main "bones of contention" become public property), I can only say that if my humble statements can be the means of eliciting from other companies facts proving the existence of larger and superior systems showing equally good or better results than those of the Société Anonyme, etc., of Paris, I shall have at least afforded some assistance in obtaining some important electrical facts of the utmost interest and value.

S. C. C. CURRIE.

NEW YORK CITY.

LEONARD'S NEW THREE-WIRE SYSTEM.

In your issue of June 15, there appeared a letter from Prof. Elihu Thomson, stating that there was nothing new in the three-wire system described by me in your issue of June 8, and claiming that all the results obtained by my system had been previously obtained by himself and Mr. E. W. Rice, Jr. In support of his statement, Prof. Thomson refers to his patent No. 360,125, of March, 1887; Mr. Rice's patent No. 460,364, of September, 1891; patent to Thomson and Rice No. 468,123, of February, 1892; and patent to Thomson No. 468,122, of February, 1892.

Prof. Thomson states that I did not distinctly claim the new three-wire system as my invention, but left the reader to infer this. I certainly intended to claim it, and my patent No. 476,544, of June, 1892, which covers the invention, leaves no room for doubt on this score.

Regarding the patents Prof. Thomson names, careful examination will show that there is no anticipation whatever. Prof. Thomson's patent No. 360,125 contemplates the use of a motor-generator which takes the surplus energy from one side of a three-wire system and transfers it to the other. If this motor-generator could be operated absolutely without loss the method would be of value, but any loss due to field excitation, friction, heating of armature, etc., is fatal, which Prof. Thomson clearly recognizes in his patent, when he says:

> "It is essential that the resistances of the windings A be so low as to be negligible and that their opposition to passage of current, under normal conditions, be due to counter-electromotive force solely."

Fig. 6 of the patent to which Prof. Thomson refers, shows a storage battery, which is connected rapidly, first to one side and then to the other side of the system, so as to receive a charge from the side of high E. M. F. and deliver it instantly to the low side, the object and result of which is entirely different from my use of the battery.

Mr. Rice's patent No. 460,364—the first claim of which is quite broad—has the fatal weakness of being inoperative. Through a curious error, it is assumed in the specification that to convert the compensating dynamo from a generator to a motor, its field must be reversed, and for this purpose its principal winding is a series winding so that, when the current in the neutral wire changes in direction the field of the compensating machine reverses. Following is a quotation from the specification:

> "If L be the lightly loaded side, the current flowing in D′ (the series winding) will be in the same direction as S′ (the shunt winding) and increase the initial excitation of the field, *so that a reversal of the field will occur* and the equalizing machine, becoming a generator, will deliver current to the heavily loaded side, drawing the necessary power from the main driving shaft."

The specification is very hazy in parts and seems to give indication of serious doubt in the mind of the inventor of just what will occur in the neutral wire under changes of load; but the *reversal of the field* is emphasized several times as an essential feature and is claimed distinctly in claim No. 8, which reads, as follows:

"The combination of a multiple series distribution system with an equalizing machine, connected in shaunt around one of the multiple arc groups and coupled mechanically with the main generator, *said machine being so wound that its field is reversed according as the shunted side has the lighter or heavier load*, thereby causing it to act both as a motor and generator, as set forth."

It seems impossible that any one familiar with dynamos and the three-wire system should seriously propose this method of operation, for evidently if we reverse the field there will be a time when the field will be reduced to zero and the dynamo will produce no E. M. F. The neutral wire will then be connected to the outside wire by the short circuit of merely the armature resistance and all the lamps on that side of the system will be short-circuited and the lamps on the other side will be exposed to the full pressure of the larger generator, which, being double the E. M. F. of the lamps, will burn them all out instantly.

As regards the other two patents, which were issued last February, they are very narrow in their scope and cover methods of shifting a dynamo *acting as a motor only*, from one side to the other of the system. A change in the potential of the neutral is caused to actuate an automatic switch, which transfers the motor from one side to the other. The best relays for such a purpose require 2 volts change in pressure to actuate them. A change of 2 volts in the potential of the neutral occasions a change in the E. M. F. on the lamps of 4 volts, as it is added to one side and substracted from the other. Hence, the operation of a switch, such as this, would cause frequent change of 4 volts—or about 4 candles—upon the different lamps in any customer's place, which would not likely be considered as an "improvement" on the method I employ, which necessitates a constant potential on the neutral.

Those practically familiar with the three-wire system will appreciate that a constant potential on the neutral, throughout the entire system, is essential for successful operation and any deliberate change in the potential of the neutral, such as these four patents contemplate, seems to carry one back to '83, when the last of such methods was abandoned, in the shape of the old house changing switch.

"The proof of the pudding is in the eating." A central station plant has been operating under my system for over six months, at Charlestown, W. Va., under peculiarly difficult conditions, as to distribution, and has had no expert attention from the day it started, and has operated perfectly in every way. If the same is true of the methods patented in the patents which Prof. Thomson refers to, no information has reached the public to that effect, although I am aware that various experiments in this line have been tried at Bridgeport, Conn., with a view to avoiding the necessity of using the Edison patent, which the Bridgeport Company is infringing by the use of an Edison three-wire system, installed by the Thomson-Houston Company.

H. WARD LEONARD.

NEW YORK, June 17, 1892.

BRAKING CARS ELECTRICALLY.

I NOTICE in your issue of May 11, a description of a method of stopping electric cars, devised by Mr. Sidney H. Short. I beg to call your attention to the fact that this method is by no means new, but dates back as far as 1888, where it was employed in the cars of the Observatory Hill Passenger Railway in Allegheny, Pa. Here no special device was employed, the ordinary connection of the motors being such, that by simply throwing the reversing switch, the car would act as you describe. The discovery of this action was a chance one, it being first noticed where a car refused to run down a steep grade with the brakes off. After searching in vain for the cause, it was found that the reversing switch was set wrong, and upon changing it, the car immediately started off at a good speed. The reason for this action was soon worked out and, from that time on, it was frequently used in emergencies and in wet weather, in descending the steep grades with which this road abounds. I have thought the above might prove of interest to your readers.

JOHN S. CONWER.

BREMEN, GERMANY, May 21, 1892.

STRENGTH OF THE McINTIRE JOINT.

REFERRING to Mr. F. W. Jones's very valuable article on "Breaking Strains of Various Joints in Hard Drawn Copper Telegraph Wire," in your issue of June 1, I note that mention is made therein of the McIntire sleeve, 4½ inches long, not soldered, three full twists given in making the joint. Mr. M. M. Davis, the gentleman making the various tests of joints, gave the McIntire sleeve only three full twists, whereas he should have given the sleeve at least four and a half or five full twists, to make a perfect torsion joint; as a sleeve connector four and a half inches long will shorten up with proper twisting one-half inch in its length, thus bringing the two wires and sleeve into intimate contact, and with the effect of hardening the sleeve and making it rigid, thus making a perfectly strong and substantial joint and one giving the best of electrical contact of the wires and sleeve.

Mr. Jones's Company (the Postal Telegraph-Cable Co.) were among our first patrons, their first order being placed in June, 1886, for twelve thousand sleeves for B. & S. hard-drawn copper wire, after they had made the necessary tests as to the strength and conductivity of our joints; and from that date to this the Postal Company have used about one hundred thousand of the McIntire patent connectors for hard-drawn copper wire, and never made any complaint as to the wires pulling out of the sleeves in actual practical line work. I would be greatly pleased at any time to test the McIntire patent connectors for any size or kind of wire in comparison with any or all of the quite numerous varieties of joints mentioned by Mr. Jones in his article, as to their breaking and electrical qualities.

The McIntire patent connectors have been a commercial article for the past six years, being used by all the leading telephone, telegraph, and electric light companies in the United States, Canada, and Europe, and we have as yet to receive our first complaint as to any unsatisfactory or defective working of them.

C. H. MCINTIRE.

NEW YORK, June 6, 1892.

SHORT GEARLESS MOTOR PERFORMANCES.

So much comment and misconception has been occasioned by an engraver's error in the published account in THE ELECTRICAL ENGINEER of April 13, of Professor Short's paper, read this spring before the Chicago Electric Club, that it has seemed necessary to give the correction as wide a circulation as the paper received.

The error referred to was in numbering the ordinates (abscissæ) of the curve, page 387, Fig. 3, giving the horizontal effort and speed. As this curve appeared in the printed article, the ordinates (abscissæ) were numbered 500, 1000, 1500, etc. As it appeared on the blue prints distributed by Professor Short when reading his paper, they were numbered 50, 100, 150, etc., with the final 0 of 500, 1000, 1500, etc., being clearly crossed out. It is not surprising that the curve, as it appeared in print, occasioned comment, as, according to it, a 20 h. p. gearless motor would have handled with ease a fair-sized freight train.

We would be pleased to have you give this correction publication at your earliest opportunity.

THE SHORT ELECTRIC RAILWAY CO.,
CHAS. F. UEBELACKER,
Engineer.

CLEVELAND, O., JUNE 11, 1892.

[While we regret very much that such an error should have crept into the engraving, we must be held entirely blameless in the matter, as the engravings were furnished to us by the secretary of the Chicago Electric Club, and we were thus justified in assuming them to be correct.—EDS. E. E.]

ELECTRICITY IN A MODERN OFFICE.

"THERE is a somewhat ancient proverb to the effect that the shoemaker's wife is always the worst shod, but it hardly applies in electrical circles. The snug little office of an electrical newspaper manager in this city is a very good illustration of the manner in which the new agent can be made to fill many rôles, and of the practical use to which the initiated immediately put their obedient servitor. Over his desk hang convenient incandescent lights. Behind him stands a well-worn phonograph, to which he thinks nothing of dictating fifty or a hundred letters a day. This is run as usual by a little electric motor deriving its current from a storage battery, which in turn is perennially refreshed by four ordinary gravity batteries. The whole outfit is small and inconspicuous and requires no attention for months together. At one side of the desk stands a little fan motor, also run by small storage batteries, and ready at any instant to deliver a cooling breeze. Right in front of the manager is a miniature switchboard and "buzzer" box and a portable upright telephone. With this he has instantaneous communication with eight different departments of the office, and can give instructions or receive information on any point by the mere insertion of a plug in the board. To-day all this is certainly an exceptional equipment for a business office, yet there is no reason why it should be. It is inexpensive and gives very little trouble, yet promotes health and economizes time in a way that 'must be seen to be appreciated.'"

The above paragraph is reprinted from the New York *Evening Post* of June 11, 1892, and refers to one of the new offices of THE ELECTRICAL ENGINEER at 203 Broadway, New York.

MANCHESTER, MASS., ELECTRIC CLUB.

THE MANCHESTER ELECTRIC CLUB held a meeting at the board of trade rooms last week, and in accordance with the constitution and by-laws adopted at a previous meeting, proceeded to effect a permanent organization by the election of the following officers for the ensuing year: President, G. I. Hopkins; vice-president, J. Brodie Smith; secretary, Herbert W. Eastman; treasurer, E. J. Burnham; executive committee, G. I Hopkins, ex officio, chairman, E. M. Bryant, G. A. Corson, W. H. Fairchild. The club will begin its work at once.

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JUNE 7, 1892.

Accumulators :—

Secondary Battery Plate, E. C. Paramore, 476,483. Filed Sept. 2, 1890.

Consists of a porous cup containing a grid consisting of a sheet divided into leaves and having active material surrounding it.

Conductors, Conduits and Insulators :

Metallic Circuit Cable, C. E. Jackson, 476,464. Filed Nov. 12, 1891.

An insulated conductor with two helically wound metal strips, the second being so arranged as to cover the space between the turns of the first and the convolutions of each strip being separated.

Electric Cable, W. R. Patterson, 476,484. Filed Oct. 29, 1891.

Employs a core of insulated conductors and a metallic sheath having interior longitudinal ribs in contact with the core.

Conduit for Electric Railways, W. Bradley, 476,603. Filed June 22, 1821.

Has for its object to provide a conduit which shall afford but little opportunity for the entrance of foreign substances, and shall be convenient of construction and economical in use.

Insulator Bracket, T. H. Brady, 476,604. Filed Apr. 9, 1892.

Galvanic and Thermo-Electric Batteries :—

Electric Battery, R. P. Osgood, 476,296. Filed Jan. 18, 1892.

Employs two perforated copper plates on opposite sides of the cell and connected together; the outer plate immersed in a solution of blue vitriol and the inner in an acid solution.

Galvanic Battery, M. M. Clark, 476,733. Filed Dec. 26, 1888.

The invention consists in mounting the carbon plates in the lead cover, in providing a lead binding post upon the cover and a wooden ring for supporting the cover upon the jar.

Distribution :—

Electric Lighting System, A. Sechrist, 476,422. Filed Dec. 1, 1891.

Provides means for turning incandescent lamps on or off from a distance.

System of Electric Lighting, T. A. Edison, 476,527. Filed Aug. 7, 1882.

Consists in arranging the lamps in separate cross or multiple arc circuits, each controlled independently by a circuit controller.

System of Electrical Distribution, T. A. Edison, 476,529. Filed Oct. 10, 1883.

Has for its object to protect generators, etc., from lightning by means of two or more metallic conductors, translating devices connected with them in parallel and a ground connection from each conductor through a resistance.

Electric Lighting System, T. A. Edison, 476,531. Filed Apr. 26, 1881.

Employs three or more derived circuits, each containing an independent translating device, a magnet and armature in the first branch normally holding the second branch open, but closing it when demagnetized; a magnet and armature in the second branch holding the third branch open and a device for holding the armature against its contact when retracted.

System of Electrical Distribution, H. W. Leonard, 476,544. Filed Dec. 28, 1891.

Relates to series multiple distribution in which a compensating conductor is connected between the translating devices in series, and has for its object to make such translating devices independent of each other.

Dynamos and Motors :—

Safety Device for Electric Motors, E. Thomson, 476,330. Filed Oct. 16, 1889.

Employs a safety fuse mounted on a heat-conducting support subjected to the heating of the coils.

Dynamo Electric Machine, E. Thomson, 476,331. Filed Oct. 14, 1889.

Has for its object to increase the capacity of the machine and do away with the dead point in the rotation of the usual armature having a single circuit where the phase of current is zero and obtaining uniformity in the resistance to rotation.

Alternating Current Motor, M. J. Wightman, 476,346. Filed Nov. 14, 1888.

Employs an alternating current field magnet and an alternating armature, both supplied with synchronous currents from an external source and a commutator by which the armature coils in half of the magnetic field are cut out of circuit.

Brush Holder for Dynamo Electric Machines and Motors, F. B. Daggett, 476,368. Filed Sept. 8, 1891.

A carbon brush holder and retaining spring.

Electric Motor, D. H. Wilson, 476,347. Filed Aug. 28, 1891.

Has for its object to obtain greater efficiency and greater economy in construction, while occupying less space than is usual in motors of the same horse power.

Electric Generator or Motor, E. A. Sperry, 476,426. Filed Apr. 3, 1886.

Relates to the regulation of the generation of currents in a dynamo or the developing of counter E. M. F. in a motor.

Lamps and Appurtenances :—

Apparatus for Trimming Carbon Points, P. Moses, 476,292. Filed June 25, 1891.

Electric Arc Lamp, E. F. Smith, 476,425. Filed Oct. 5, 1891.

An arrangement by which the carbon feed rod is first lifted to form the arc and then moved toward the point of combustion at a speed equal to the consumption of the carbon.

Electric Arc Lamp, C. E. Scribner, 476,493. Filed Oct. 13, 1891.

Provides regulating mechanism in which a single electromagnet in shunt of the carbons regulates the length of the arc.

Incandescent Electric Lamp, E. E. Weaver and G. B. Manypenny, 476,501. Filed Dec. 5, 1891.

Employs a hollow reflector forming the inner wall of the incandescent lamp for the purpose of enhancing its brilliancy.

Incandescent Electric Lamp, T. A. Edison, 476,528. Filed March 16, 1883.

An incandescent lamp with a plurality of filaments.

Incandescent Electric Lamp, T. A. Edison, 476,530. Filed June 4, 1887. Employs two metal plates connected to one of the leading-in wires and having their surfaces near together.

Electric Arc Lamp, R. H. Thurston, 476,700. Filed Feb. 27, 1892.

Consists in twisting one of the carbons so that its end will form a small angle with the other carbon.

Miscellaneous :—

Electrical Governor, M. A. Replogle, 476,311. Filed Dec. 12, 1890.

Employs a tripodal mercury cup revolving horizontally and having a connection with the middle tube at low speed and another connection with the outer tube at excessive speed.

Electric Chime or Bell, J. H. Hunter, 476,463. Filed Feb. 29, 1892.

Consists of a gong placed near the pole of the magnet and movable under the attraction of the latter.

Electric Magnet, A. D. Ayres, 476,236. Filed Sept. 15, 1891.

Employs a series of coils and divided core armatures bound together and forming portions of particular magnetic circuits, and a commutator so arranged that the combined armatures partake of the action of the series.

Electric Body Wear, R. S. Mears, 476,478. Filed Nov. 27, 1891.

Electrically Controlled Valve, W. B. Fleming, 476,376. Filed Nov. 3, 1888.

Base Ball Game, M. Ullman, 476,334. Filed Aug. 14, 1891.

An electrical toy representing a game of ball.

System of Testing Electric Circuits, C. H. Rudd, 476,317. Filed Nov. 4, 1889.

A system of testing for grounds or weak insulation on arc light circuits.

System of Testing for Electric Circuits, C. H. Rudd, 476,490. Filed Jan. 19, 1888.

Consists of a condenser and telephone connected in the circuit and means for closing the latter from different parts of the light circuit through the telephone and condenser to ground.

Fuse Block for Electric Circuits. E. A. Sperry, 476,570. Filed March 19, 1891.

Electrical Valve Controller, J. V. Stout, 476,578. Filed Dec. 22, 1891.

Machinery for Cutting Coal and other Minerals, L. B. Atkinson, C. W. Atkinson & W. T. Goolden, 476,593. Filed Aug. 8, 1891.

Employs a yoke connecting the like poles of two electromagnets and forming a circular base for swiveling upon a traveling carriage.

Electric Light Mast Arm, J. H. Caldwell, 476,607. Filed June 19, 1891.

Electric Street Lamp Post, T Flaherty, 476,739. Filed March 23, 1891.

Electroplate Attachment, C. Keck, 476,653. Filed Dec. 22, 1891.

Process of and Apparatus for Bleaching by Electrolysis, A. E. Woolf, reissue 11,244. Filed May 5, 1892.

Railways and Appliances :—

Railway Signaling System, F. P. Benjamin, 476,240. Filed Sept. 5, 1891.

A system of automatic electric lock signals.

Trolley Support, S. C. Crane, 476,367. Filed March 11, 1892.

Electric Locomotive, T. E. Adams, 476,437. Filed May 28, 1890.

Relates to means for supporting a motor on the car and for gearing it to the driving wheels.

Switches and Cut-Outs :—

Electric Switch, C. E. Davis, 476,613. Filed Feb. 20, 1891.

Relates to means for preventing reverse rotation of the bar, to novel construction of the binding terminals, and means for insulating the metallic parts on the under side of the base from possible contact with the wall.

Telegraphs :—

Apparatus and System for Compound Telegraphy and Telephony, F. W. Dunbar, 476,618. Filed Jan. 25, 1892.

Has for its object to so connect the apparatus that while the independence of the telegraphic and telephonic signals is maintained no obstruction shall be offered to either currents.

Telegraph :—

Telegraph Instrument, C. B. Carr, 476,730. Filed Jan. 7, 1892.

A combined sounder and relay.

Telephones and Apparatus :—

Circuit for Test-Batteries and Cords of Multiple Switchboards, C. E. Scribner, 476,492. Filed June 1, 1885.

A multiple switchboard testing apparatus consisting of a battery placed in the different pairs of cords and means for determining at any given board whether or not a line wanted is connected.

Keyboard System for Metallic Circuits, J. A. Seely, 476,494. Filed Nov. 15, 1886.

Has for its object to connect the clearing-out annunciator in the circuit of one of the cords so that no current will be sent through the former when a signal of the generator is sent over the line.

Keyboard Circuit for Multiple Switchboards, O. A. Bell, 476,509. Filed Sept. 30, 1891.

Has for its object to simplify the circuit connections and the mechanism of the operators' apparatus.

Microphone, C. Vogt, 476,582. Filed May 27, 1891.

Employs a diaphragm having two recessed contact blocks insulated from each other, carbon cylinders bridging these contacts and provided with magnetic sleeves and a magnet in inductive proximity to the latter.

Magnetic Telephone, C. Vogt, 476,583. Filed Sept. 14, 1891.

Provides means for regulating the distance of the poles from one another.

PROTECTING THE RIGHTS OF MINORITY STOCKHOLDERS—T. C. MARTIN vs. THE W. J. JOHNSTON CO., LIMITED.

A POINT of interest to stockholders in business corporations was decided June 17th by the Court of Appeals in the case of Thomas Commerford Martin vs. The W. J. Johnston Company, Limited.

Mr. Martin, who was and is a stockholder in the W. J. Johnston Co., believing that its affairs were being improperly managed by its president, who for two years has paid no profits except to himself, obtained from Judge Lawrence of the Supreme Court, through Masten & Nichols, his attorneys, a peremptory writ of mandamus requiring the company to exhibit its books to him and to allow him to make extracts or memoranda therefrom. The company resisted the application, claiming that Mr. Martin was not a stockholder; that he had no right in any event to make extracts from the books, but only to inspect them; that his demand was irregular, having been made upon the treasurer instead of the secretary, and that his motives for the examination were improper as he was interested in a rival corporation.

The case was very strenuously litigated by the company, which not only endeavored to obtain a stay of the writ, but also carried it twice to the Court of Appeals. This court has now, finally, held, affirming the decision of the General Term, that the writ was properly issued and that Mr. Martin was entitled to the granting of the application as fully as it was allowed.

Personal.

MR. HENRY W. GOODE has been elected second vice-president of the Northwest Thomson-Houston Electric Co. Mr. Goode has earned a high reputation by his very efficient work on the coast, and this election may be said to mark another stage in his career.

MR. A. A. ALDEN has succeeded M. J. King as electrical engineer of the Bristol, R. I., Electric Lighting Co. Mr. King will hereafter be connected with the Westinghouse electrical interests in Chicago.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The wise man does not hesitate to spend in advertising what a lawyer would charge for superintending his assignment.—Texas Siftings.

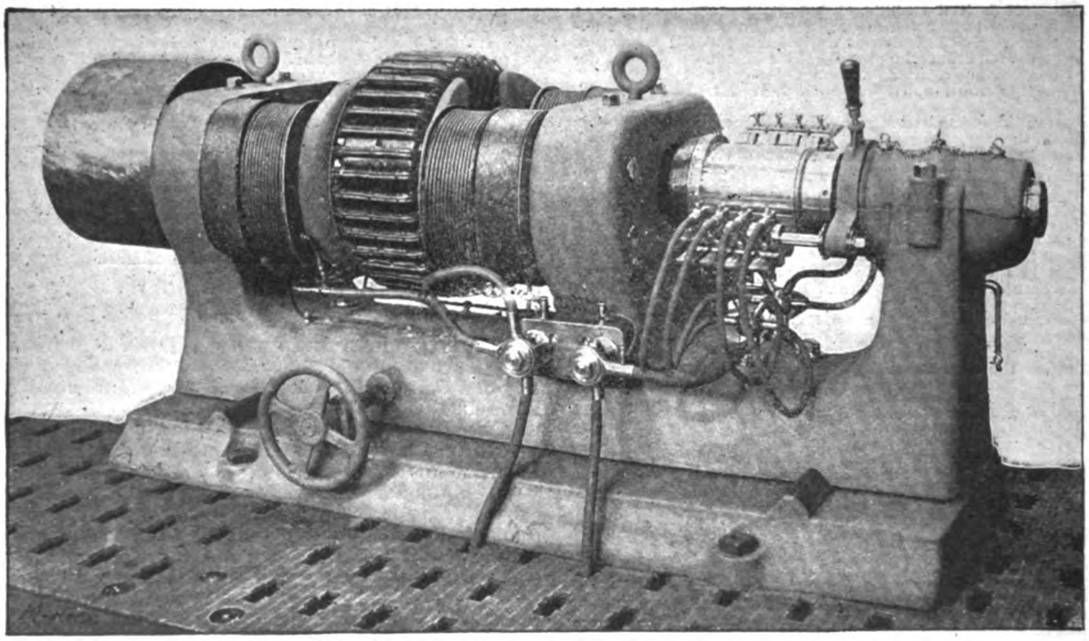
THE BRUSH DIRECT CURRENT INCANDESCENT DYNAMO.

THE accompanying illustration shows the latest improvement in Brush dynamos. It is a new machine of the closed-coil type, with an armature having many bobbins and few turns of wire. The commutator is made of pure copper and mica, and is said to be absolutely sparkless and indestructible.

The frame is cast in one piece, fitted upon V's, which are cast on the bedplate, and is bored out at each end to receive the adjustable self-oiling ball bearings that carry the armature shaft. The field magnets are of soft cast steel, are compound wound, and require only about 3 per cent. of the output of the machine to excite them.

The armature is of the smooth ring type, with iron spacing lugs only. It is made of very thin iron ribbon wound like tape, and has a section about as large as the rest of the magnetic circuit. It contains 36 independent bobbins, whose ends are connected with their corresponding commutator bars by means of wires passing directly from the armature to the commutator outside the shaft. The brushes, about half an inch thick, are made of alternate layers of fine copper wire and thin sheet copper.

The machine, as a whole, is claimed to require less attention than any other in use on account of the care expended upon the design of the commutator, the adjustment of the brushes and the automatic lubricators. It is made in seven sizes, ranging in capacity from 35 to 600 lamps.



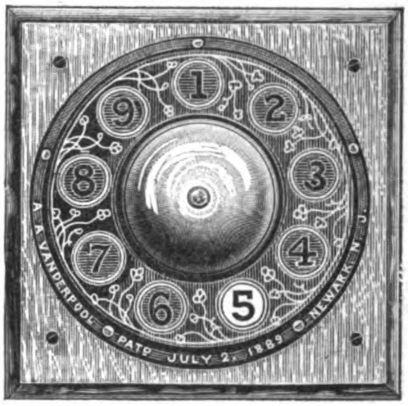
BRUSH DIRECT CURRENT INCANDESCENT DYNAMO.

A CURIOUS WAY OF ADVERTISING.

IN the show window of a store in Wilmington there is a glass case in which is a pivoted Crocker-Wheeler motor with a fan, and about two pounds of feathers. When the motor is in operation it revolves completely around a circle throwing a strong current of air and causing the feathers to fly around in all directions. The crowd about the window is so great that it requires two policemen to keep them away, and as a natural result the dealer is growing rich from his sales of motors. We learn incidentally that the Crocker-Wheeler people are receiving more orders for these pivoted motors than they can fill, and they will undoubtedly have an immense sale. The Crocker-Wheeler Electric Company own the fundamental patent upon this principle as well as the patents on the special devices, and intend to hold the field against all comers.

THE VANDERPOOL SELF-ADJUSTING ANNUNCIATOR.

THE convenient annunciator of which we present an illustration, is the invention of Mr. A. A. Vanderpool, of Newark, N. J. It is self-adjusting, as there are no drops to be replaced, no clockwork or springs, in fact, absolutely no handling of the instrument is required. It can be so constructed as to be flush with the wall or other article upon which it is placed. The numbers or letters if desired are painted on glass discs which are transferable. At the push of the button these become illuminated, as it were, making a most desirable contrast and standing out boldly. The mechanism is very simple, and it is almost impossible for it to get out of order. Mr. Vanderpool would like to arrange with some company for the exclusive manufacture of his annunciator. It can be nicely arranged for from one to seventy-five drops.



VANDERPOOL SELF-ADJUSTING ANNUNCIATOR.

THE ALLIS EXHIBIT FOR THE WORLD'S FAIR.

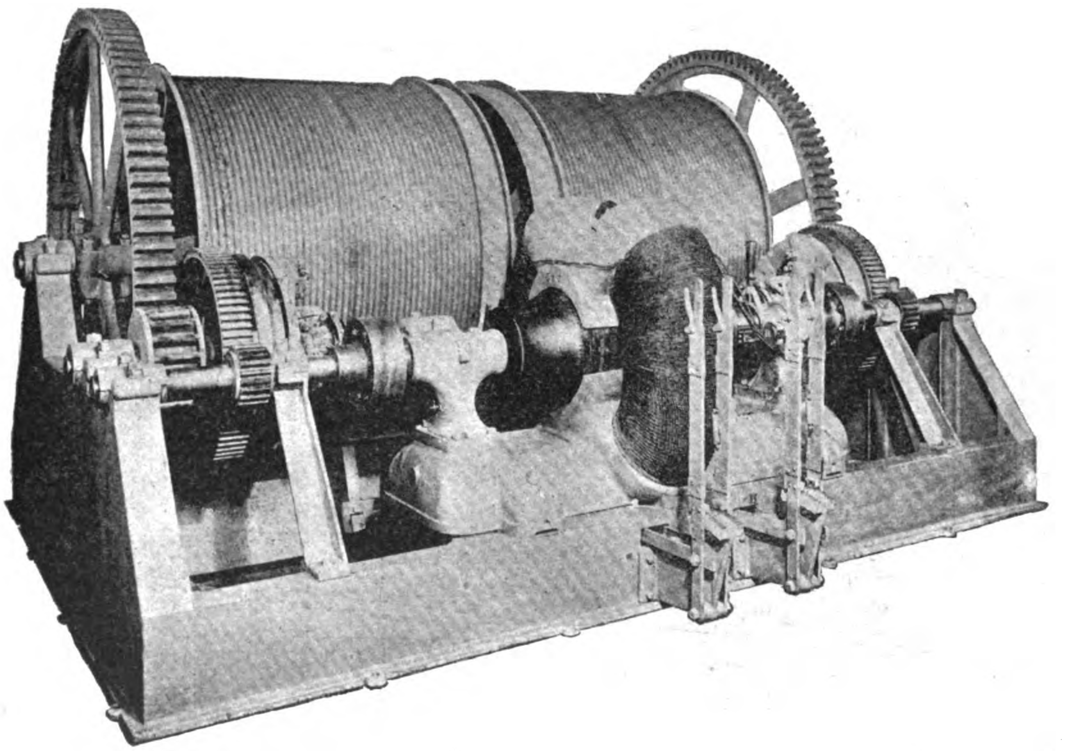
THE chief motive power for the machinery at the Exposition will be supplied by a gigantic engine, to be furnished free to the Exposition by the E. P. Allis Company, of Milwaukee. The engine will be furnished as a part of the company's exhibit, upon a special contract providing that it shall be used for the motive power, and that no other engine of equal size shall be exhibited. It will be an engine of the quadruple-expansion type, and will be of between 3,000 and 4,000 h. p. Compared with this engine the big Corliss that was exhibited at the Centennial Exposition is almost a dwarf. In 1876 the Corliss was rightly considered one of the wonders of the exposition, but its builder rated it at only 1,400 h. p., or less than half of the one being built by the Allis company. The Allis exhibit represents an outlay of $175,000.

THE ELMIRA ILLUMINATING COMPANY.

A NEW station, 66 x 177 feet, with boiler-room and storehouse in addition, is to be erected by the Elmira Illuminating Company of Elmira, N. Y. A 6-foot stack, 150 feet high, will be built and the new equipment will consist of two engines of about 1,500 h. p. capacity, triple expansion, with the necessary condensers; boilers of 1,500 h. p. capacity to carry 160 pounds pressure; shaft 185 feet long with friction clutch pulleys, clutches, floor stands, etc.; an overhead crane of ten tons capacity, a tank and boiler feed pumps, belting, lines, wires. There will be an iron-trussed roof over the machine and boiler-rooms. Work will be commenced immediately. The Elmira Illuminating Company is now owned by the Elmira Municipal Improvement Co. as is also the Elmira Gas Co., the Elmira and Horseheads Railway Co. and the Elmira Water Works Co.

"C. & C." ELECTRIC MINE HOIST.

THE accompanying illustration shows an electric mine hoist recently installed by the C. & C. Electric Motor Co. in a mine at Corbin, Montana. At a rope speed of 400 feet it lifts a weight of 5,000 pounds. There are two drums, each five feet in diameter by forty inches long, intended to run either separately or together, independently geared by two reductions to each end of the motor shaft. The motor pinions are rawhide, and their motion is transferred to the intermediate shafts by means of two Frisbie friction clutches. The motor is 65 h. p. and is reversible. The reversing and speed regulating switch, not shown in the engraving, is placed conveniently near the operator of the four levers shown. Two levers are for throwing the clutches in and out, and two for applying the break-band on the inner peripheries of the drums. The bearings have ample length and the whole machine is substantially and well made. It occupies a floor space of about ten by thirteen feet and has a total weight estimated at sixteen tons.



"C. & C." ELECTRIC MINE HOIST AT CORBIN, MONTANA.

THE ELECTRIC ROAD AT OTTAWA, CANADA.

AT a recent meeting of the Board of Trade of Ottawa, Canada, the operation of the local electric street railway was discussed, and the opinions expressed were decidedly favorable to electric traction.

The electric railway was endorsed as not only having proved to be a great convenience to the public, but as a benefit to the stores along its route, from a business point of view. As one merchant put it "electric railways drew trade to the stores by which they passed." At the close of the meeting, a resolution was passed unanimously, favoring the adoption of electricity as a motive power on the remaining horse railways in the city.

When the electric railway first began running at Ottawa, a year ago, it was confidently predicted by many that it could not be operated successfully during the winter, but the experience of the past year has proved to the contrary, for the road has run on time all winter in spite of heavy snows and severe storms. The system used at Ottawa is the Westinghouse single reduction. The road is 15 miles in length and has 30 cars. The contractors were Ahearn & Soper, electrical engineers, Ottawa, and the same firm is now installing a plant of 30 Westinghouse cars at Hamilton, Ont.

BALL ENGINES.

THE SCHUYLKILL ELECTRIC RAILWAY CO., Pottsvile, Pa., have recently placed a 200 h. p. engine. built by the Ball Engine Co., Erie, Pa. J. C. Hubinger Co., Electric Light Co., of Keokuk, Iowa, have just installed a 300 h. p. cross-compound condensing engine, built by the Ball Engine Co. The engine is giving fine satisfaction. F. R. Dravo & Co., the Pittsburgh representatives of the Ball Engine Co., recently furnished one 50 and one 100 h. p. engine to the Pittsburgh Iron and Steel Engineering Co., Pittsburgh; one 130 h. p. engine to the Moundsville Electrical Co., Moundsville, W. Va.; and one 80 h. p. engine to the Oakland Light and Power Co., Oakland, Md.

ELECTRIC ROADS AT DULUTH, MINN.

THE NORTHERN CAR COMPANY will soon ship, equipped and ready to be transferred to the street car tracks, the first of the new car bodies ordered for the Duluth Street Railway Company. This car is equipped with two 20 h. p. Short gearless motors, and will be placed on the line at the head of the incline and back of the city of Duluth. This line is 1¼ miles long and overlooks the entire populated district at the head of Lake Superior. It is 650 feet above the lake level, and the incline by which it is reached was built at a cost of $250,000. The maximum grade of the road on which these gearless motors will be operated is 4½ per cent.

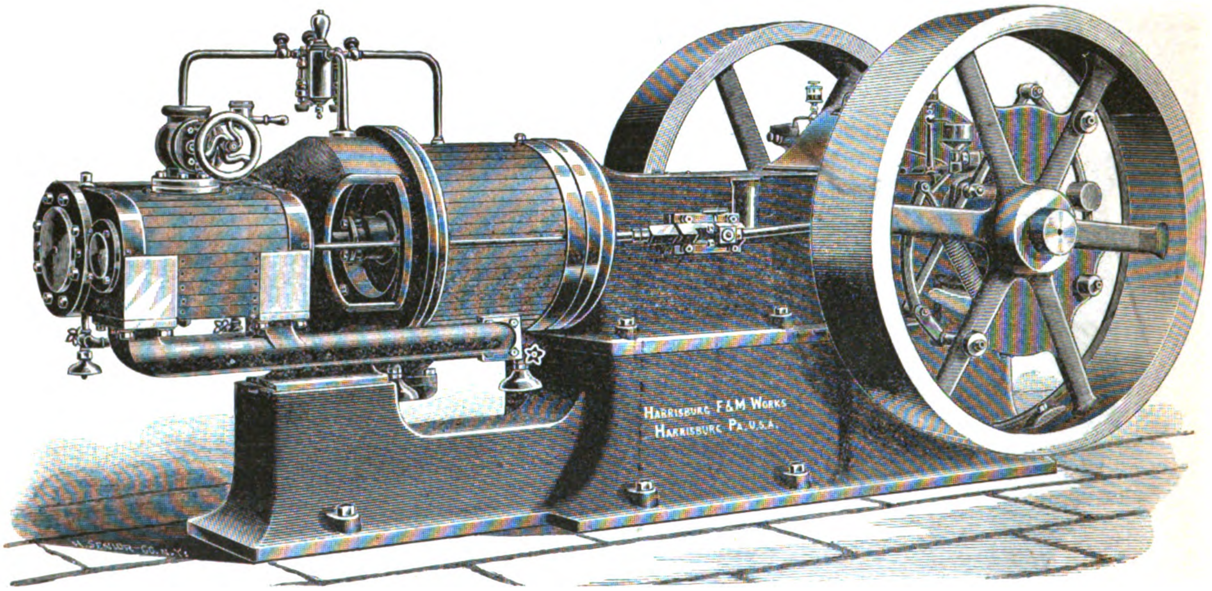
DALLAS, TEX.—Mr. C. O. Harris, the well-known electrician, has recently become connected with the Garrett Electric Machine Works, 474 Live Oak street, Dallas. He has just finished installing a very fine Westinghouse alternating plant at Calvert, Tex., run by an "Ideal" engine of 45 h. p. The streets are lighted by 50 c. p. lamps every 125 feet in the business district, and with 32 c. p. lamps in the residence district every 500 feet. The full 500-light capacity of the plant has been installed. The station is handsomely finished throughout in native woods. Mr. Harris also put in a fire alarm service with 16 stations. Mr. Garrett, his business associate, is also an old electrical man of wide experience, and inventor of the Garrett burglar alarm screen and cash drawer.

THE HARRISBURG IDEAL TANDEM COMPOUND ENGINE.

The Harrisburg ideal tandem compound engine, manufactured by the Harrisburg Foundry and Machine Works of Harrisburg, Pa., and shown in the accompanying illustration, presents some very novel and striking features aside from the self-oiling feature which has made the simple Ideal engine very popular for electric light and manufacturing purposes.

This engine is designed with special regard to high economy, and independent valve motions are provided for high and low-pressure valves, both valves of the piston type. The low-pressure valve is made with an adjustable packing that is claimed to overcome all the objections to piston valves as heretofore manufactured. Another feature in the construction of the engine is the accessibility of the low-pressure piston and cylinder without dismantling the high-pressure cylinder, steam, and exhaust pipe. The connection between the two cylinders is so made that the piston can be moved into this space for examination by simply removing the cylinder heads. The support for the high-pressure cylinder is provided by the extension of the sub-base, which makes a substantial support and avoids any vibration of the cylinder when doing heavy work.

These engines are especially adapted to electric light and electric railway work. The prominent advantages claimed are automatic lubrication, close regulation under varying loads, accessibility to all the parts, perfect equilibrium of the engine when in action, large bearing surfaces, and high economy. A number of these engines have been built and are in operation, giving very satisfactory results. The following agents represent the company: New York, W. R. Fleming & Co., Mail and Express Building; Philadelphia, Frank Johnston, Master Builders' Exchange; Boston, the Post Engineering Co., 180 Summer St.; Pittsburgh, J. A. Robinson, Room 703 Penn Building.



Harrisburg Ideal Tandem Compound Engine.

HARRISBURG IDE AND IDEAL ENGINES.

W. R. Fleming & Co., new Mail and Express Building, New York City, agents for the Harrisburg Foundry Machine Works, have handed us a list of recent contracts for furnishing Ide and Ideal engines. When it is remembered that the sales mentioned below represent only a comparatively small proportion of the United States, and that we happen to know that other agents as well as the factory themselves have each been shipping almost as large a number as is handled through New York City, it is safe to infer that not only is the sale for the Ide and Ideal engines rapidly increasing, but they are doing as large a business as any other engineering concern in this country.

The following list covers the last few weeks' business done by W. R. Fleming & Co. alone, and equals over 2,500 h. p.: One 70 h. p. Standard Ideal engine, one 150 steel horizontal tubular boiler, Edison Electric Light Co., North Plainfield, N. J.; one 60 h. p. Standard Ideal engine, one 60 h. p. vertical boiler, Bar Harbor, Me.; one 30 h. p. Standard Ide engine, one 30 h. p. vertical boiler, McMahon & Wren, Bridgeport, Conn.; four 100 h. p. special direct-connected Ideal engines, Mail and Express Building, New York City, N. Y.; three 100 h. p. Standard Ide engines, Pope Mfg. Co., Hartford, Conn.; one 25 h. p. Ideal engine for steamship service, Harlan & Hollingsworth Co., Wilmington, Del.; one 16 h. p. Standard Ideal engine, steam yacht "Clarion," Newport; one 45 h. p. Standard Ideal engine, Central Stores, New York City, N.Y.; one 55 h. p. Standard Ideal engine, Wild & Williams, New York City, N. Y.; two 225 h. p. Standard Ideal engines, Clarion Mills, Pa.; one 25 h. p. Ideal engine, Weehawken Ferry Co.; one 80 h. p. Standard Ideal engine, one 50 h. p. Standard Ideal engine, Naval Observatory, Washington, D. C.; one 55 h. p. Standard Ideal engine, one steel horizontal tubular boiler complete steam plant, Brazil; one 12 h. p. Standard Ide engine, Whitlock Coil Pipe Co., Elmwood, Conn.; one 55 h. p. Standard Ideal engine, one 60 h. p. Standard Ideal engine, Century Club, New York City, N. Y.; one 150 h. p. special railway Ideal engine, one 80 h. p. special railway Ideal engine, one 55 h. p. Standard Ideal engine, Chillicothe Street Railroad and Lighting Co., Chillicothe, Ohio; one 55 Standard Ideal engine, Hyland Paper Co., Johnsonburg, Pa.; two 60 h. p. Standard Ideal engines, Hotel St. Lorenz, New York City, N. Y.; five 25 h. p. Standard Ideal engines, Pacific Mail Steamship Co., New York City, N. Y.

A FACTORY OPPORTUNITY AT MARION, IND.

Mr. Geo. L. Mason, president of the Inter-State Trust Co., room 705, 925 Chestnut street, Philadelphia, Pa., can give information as to the opportunity to secure a factory building at Marion, Ind., with natural gas, coal and oil advantages. A warrantee deed will be given to a plot of ground 99 by 132 feet, containing a new two-story brick building 40 by 80 feet, substantially built for manufacturing purposes, with natural gas free for light, heat and furnace use. This deed can be secured by any person who agrees to occupy the building for manufacturing purposes and to employ not fewer than 10 men. This matter has, we may say, been brought to our notice by Edwin Harrington & Son, machine tool makers, of Philadelphia, Pa., who have been building special machinery for the Standard Hub Co. at Marion. They say that the factory is a good one, in good location for manufacturing.

STEARNS MANUFACTURING CO.

The Stearns Manufacturing Co., of Erie, Pa., proprietors of the Woodbury automatic highspeed engine, are advised that the Franklin Institute has awarded to the Woodbury the Edward Longstreth medal of merit, stating:

> "The sub-committee after witnessing the operation of several of these engines were impressed with the fact that the skill and intelligence displayed in the design and construction of the engine, had resulted in a machine of handsome appearance, capable of close regulation of speed, smooth in its action, and well adapted for its purposes.
>
> Recognizing the integrity and skill displayed, your committee recommends the award of the Edward Longstreth medal of merit."

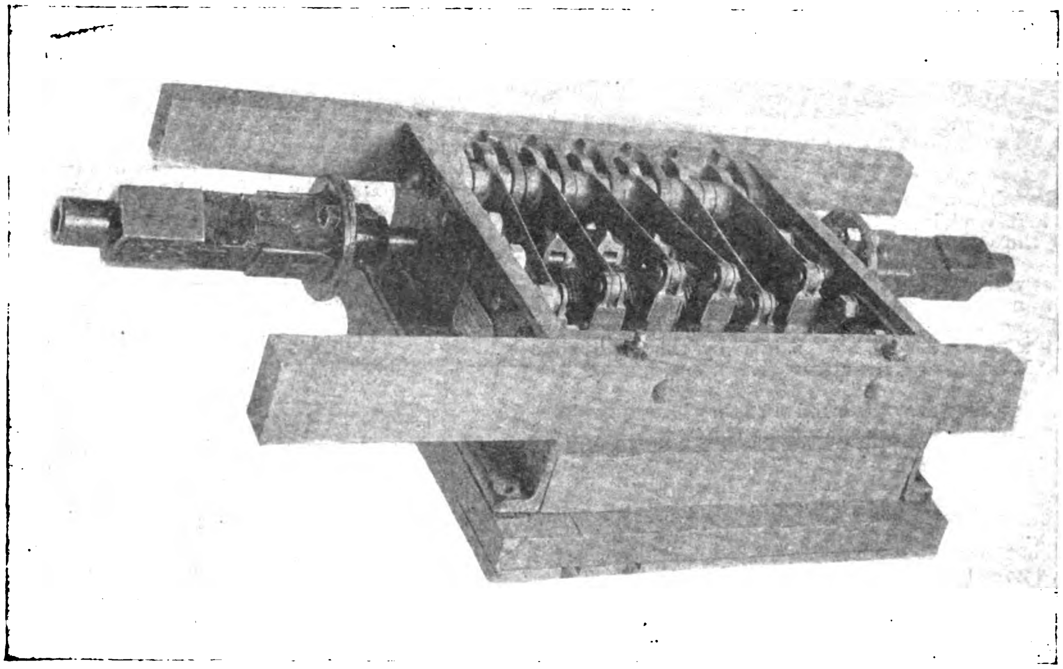
James Christie, Chairman.
J. M. Emanuel.
Spencer Fullerton.
Joseph E. Codman.
Thomas P. Conard.
John H. Cooper.
Adopted May 4, 1892.

Arthur Beardsley, Chairman,
Committee on Science and the Arts.

NEW THOMSON-HOUSTON ELECTRIC RAILWAY CONTROLLER.

The Thomson-Houston Electric Company has for a long time been engaged in experiments, having in view the development of a controller for railway motors that would be an improvement on those now generally used.

It is well known that the regulation of motors by means of a resistance only is decidedly wasteful as well as troublesome. In fact, it involves the consumption of nearly as much energy when the motor is running at a slow peed as when running at a high speed, although the work given out by the motor in the two cases is very different. It simply means that the energy which, in the one case, drives the motor at a high speed is, in the other, partly expended upon the resistance and the remainder, only, is used to drive the motor. It has been customary to modify this method of regulation in well-designed plants by providing, in addition, a device for changing the field magnets of the motor so that the counter-electromotive force for a given speed will be greater and permit, in consequence, the use of a smaller amount of resistance. In some cases these two methods of regulation,—by means of resistance and alteration in field magnet strength,—have been combined in a system of commuting sections of the field magnet coils, by which the coils themselves offer a greater or less resistance to the passage of the current and at the same time have a variable effect on the field magnet strength. In other cases the combination of the two methods has been effected by having a separate resistance external to the motor and then, in addition, providing a switch to cut out a section of the field magnet coils or "loop" as it is often called, or to shunt a portion of the current around them for highest speed.



New Thomson-Houston Electric Railway Controller.

After a long series of experiments the Thomson-Houston Company is now furnishing a controller which, it has satisfied itself, is thoroughly practical, and which at the same time realizes almost a perfect theoretical economy in regulation. In a number of instances where this regulator has been used for some time a saving of thirty per cent. in consumption of current has been effected; and when it is realized that this means a saving at the central station of over three hundred horse power out of a thousand, the great importance of this new device cannot be doubted.

The principle upon which the new controller is based is the shifting of the connections of two motors from series to multiple; so that for slow speed the two motors will be in series, giving in consequence a high counter-electromotive force, that of one motor being in series with that of the other at a low rate of speed; while for higher speed they are connected in multiple, in which condition highest speed and power are obtainable with equal economy.

In the accompanying illustration the general form of the apparatus which the company has adopted for effecting these changes is shown. The apparatus consists of a longitudinal shaft acting upon a series of switch levers to produce the various connections necessary to place the motors in series or parallel. This controller can be placed at any point beneath the car and operated by a mechanical connection from either end of the vehicle. In this apparatus the mechanical and electrical details have been worked out with the greatest care, and it was permitted to go on the market only after satisfactory tests had been made, proving the efficiency and reliability of the device, on which the company claim to own the controlling patents.

NEW ENGLAND NOTES.

Perry & Demeritt, of Montpelier, Vt., have issued a very interesting illustrated catalogue, showing their well-known "L. P. & D." system of driving dynamos. This system, though comparatively new, has already stood many severe tests, and has been in operation in several electric light stations and isolated plants for some years with marked success. Messrs. Perry & Demeritt claim that with their system they get increased driving power, a large saving in space, and less friction on the bearings, and that it is the cheapest system to set up and the easiest to maintain. The system is extremely simple and substantial, and electrical engineers would do well to investigate its merits while designing electric plants, as it appears to offer them a number of advantages of much importance to them.

The Boston Electric Company, of Boston, report a very large and increasing demand for their celebrated double-armature automatic electric gas lighting burners. These burners are operated by a single impulse of the electric current, which turns on and lights the gas. The armature is so arranged that repeated hammer blows can be given, should the valve become stuck or hard to work an account of friction or poor gas, a property which all other burners in the market, they claim, are deficient in.

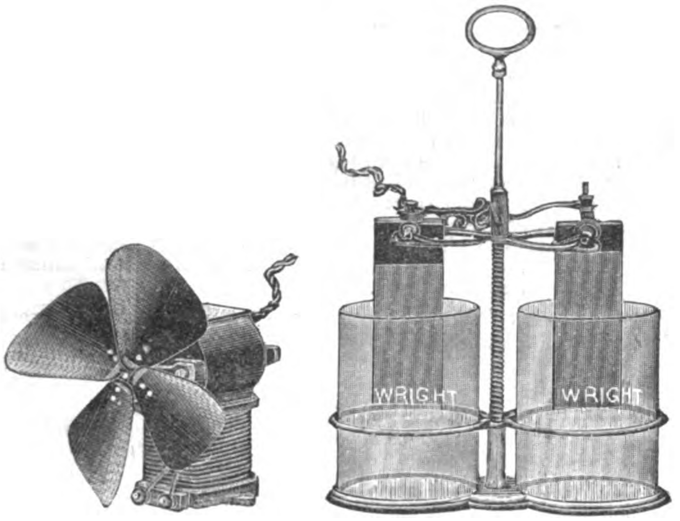
Pettingell-Andrews Company.—At a meeting of the directors of the Pettingell-Andrews Company, Mr. C. H. Price was elected president, in place of Mr. F. E. Pettingell, who has resigned from all active business, owing to his continued ill-health. The other officers of the company remain as before, namely, Mr. D. A. Andrews, Sr., treasurer; Mr. D. A. Andrews, Jr., assistant treasurer, and vice-president; and Mr. C. B. Price, secretary.

Mr. E. R. Tilton has resigned his position with the Pettingell-Andrews Company of Boston, and accepted a position with Mr. C. S. Knowles, of Boston, in the sales department. Mr. Knowles deals in a variety of rubber and other specialties well known to the electrical trade, and Mr. Tilton from his past experience with the trade in New England will form a valuable acquisition to him.

Mr. J. B. Bennett, who for years has been well known as the general manager of the National Telephone Company, has resigned his position with that company, and is now no longer connected with them. Mr. Bennett will keep in close touch with the telephone business, and will announce himself again to his many friends at no very distant date.

"ELECTRIC SAND."

A PRIMARY battery generating current at a cost of $\frac{1}{84}$ cent per horse power hour seems almost sufficiently remarkable to be classed under the head of miracles, yet such an one is claimed by the Wright Universal Electric Co. of 26 Whitehall street, this city. In this battery is used a compound termed "electric sand," and water. The "sand" is a slightly moist, dark-red substance which dissolves readily in the water. No gases are given off from the battery and it is claimed that there is absolutely no local action and that the consumption of zinc is reduced to a minimum.



WRIGHT BATTERY AND MOTOR.

The accompanying illustration shows a two-cell battery driving a Wright fan motor. Each cell contains about five ounces of "sand" and one pint of water. A two-cell storage battery measuring 4¾ x 1¼ x 3⅞ inches is also shown by this company. Measured by a Weston voltmeter this gives a reading of five volts.

The company say they are convinced that they have solved the primary battery problem and are anxious to convince others that they are correct.

PIERCE & MILLER ENGINEERING CO.

THE old firm of Pierce & Thomas having gone out of business, and Mr. F. M. Pierce having purchased the interest of Mr. R. H. Thomas, the Pierce & Miller Engineering Co. will take up the work of the former concern. The new company will continue at the familiar address, 42 Cortlandt street. It will be composed as follows: F. M. Pierce, president; J. D. Miller, vice-president; W. H. Stalnaker, secretary and treasurer; F. Schmerber, chief engineer, and W. B. Hadley, electrical engineer.

These are all well-known and thoroughly experienced men, who between them have an intimate acquaintance with the personnel and practice of mechanical and electrical work. The company will continue as general sales agents of the McIntosh & Seymour Engine Co.; Porter Mfg. Co.'s engines and boilers, T. M. Nagle and the Pennsylvania Boiler Works' engines and boilers, and the Young-Brennan Crusher Co.'s rock and ore crushers. Under its new auspices the company will go more extensively into the business of engineering and contracting for complete steam plants for electric railway, lighting and manufacturing purposes, and will also give special attention to mining equipments.

WESTERN NOTES.

THE RAILWAY EQUIPMENT COMPANY, Chicago, reports for the last week orders for the complete equipment of roads in New Haven, Connecticut; Brooklyn, New York; Baltimore, Maryland; Evansville, Indiana; Chillicothe, Ohio; Pittsburgh, Pennsylvania; Hamilton, Canada; Augusta, Georgia; Kokomo, Indiana, and Put-in-Bay, Ohio. They have also made during the same time large sales for extensions of present roads. The business of this company is constantly increasing. The standard material of their manufacture is known to be reliable, and their facilities for promptly filling orders are unequaled.

MR. ALBERT SECHRIST, electrical engineer, of Denver, Col., expects to take an extensive trip East, this month, which will combine business with pleasure.

SAMUEL F. HODGE & CO., of Detroit, Mich., have adopted the plans of the Berlin Iron Bridge Co., of East Berlin, Conn., for their new foundry, and have placed the contract with the Berlin Company for the construction of the building. It is expected that this will be the most perfect and best-appointed foundry in the Northwest. The general dimensions of the building are 86 ft. in width by 161 ft. in length. On each side there is a wing 23 ft. in width. The centre of the building is controlled by a traveling crane with a travel the full length of the building. The wings of the building are controlled by jib cranes, so that when completed, every inch of the floor surface will be controlled by power, either from the traveling crane or from jib cranes. The construction will be entirely of brick and iron.

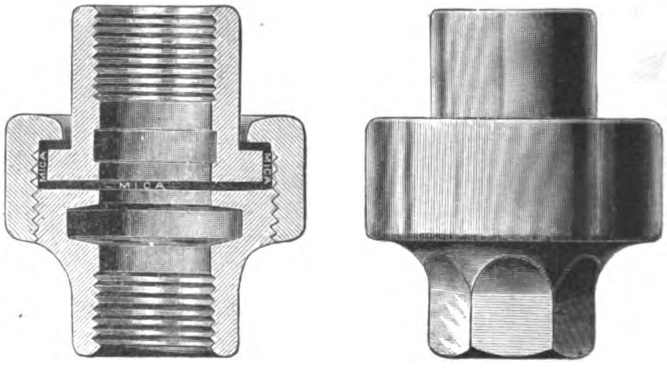
THE MESTON ALTERNATING CURRENT FAN MOTOR is having an immense sale, and although the manufacturers prepared for a very large demand on the strength of their success last year, they are nevertheless already behind on their orders and the demand is daily increasing. The Electric Appliance Company as Western agents report a very large number of sales, and state that their orders come from all over the United States from Maine, Oregon and South to Florida, showing how well they have advertised this specialty. They are carrying a large stock in Chicago and are in the best possible shape to fill orders.

THE SEBASTIAN LATHE CO., of Cincinnati, O., are well and favorably known to all users of machinery and machine tools. They pay special attention to the manufacturing of lathes adapted to electrical work, large and small. It is needless to say that the employment of good appliances of this kind has much to do with the quality of the electrical apparatus turned out, and hence it pays to get tools and mechanical plant from such trustworthy and reputable concerns as that above named.

THE SPERRY ELECTRIC MINING MACHINE CO. are having a very large sale of fuse wire. They were among the first to advocate the use of a tested fuse wire which could be absolutely relied upon to open the circuit upon any excess of current above the predetermined. They have continually made improvements in its composition and manufacture and have accurately determined its action under all conditions. The universal satisfaction given by the fuse wire has made it a prime favorite among users.

MICA INSULATING JOINTS.

THE accompanying illustrations show the "Roberts" insulating joint, manufactured by Vallee Bros. & Co., 17 North Sixth street, Philadelphia. It is small and simple in construction, insulated entirely with mica, and is claimed to be fire, water and acid proof. Ingenious locking devices are used to prevent the turning of the parts upon each other. The illustrations are full size.



THE "ROBERTS" INSULATING JOINT.

COL. WM. M. EDGAR, U. S. Vice-Consul, city of Mexico, is in New York on business, and is the guest of his friend, Mr. Chas. McLaughlin, of the firm of J. H. Bunnell & Co. Under these happy auspices, Col. Edgar has found New York a pleasant place to be in even during the hot weather. As one familiar with Mexico and its history, Col. Edgar makes the admirable suggestion that a fine series of Mexican tableaux could be arranged for El Dorado, the very name having an appropriateness. With the electrical effects in Mr. McLaughlin's hands, we would be glad to see the idea carried out next season. It would make a brilliant hit.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

THE
Electrical Engineer.

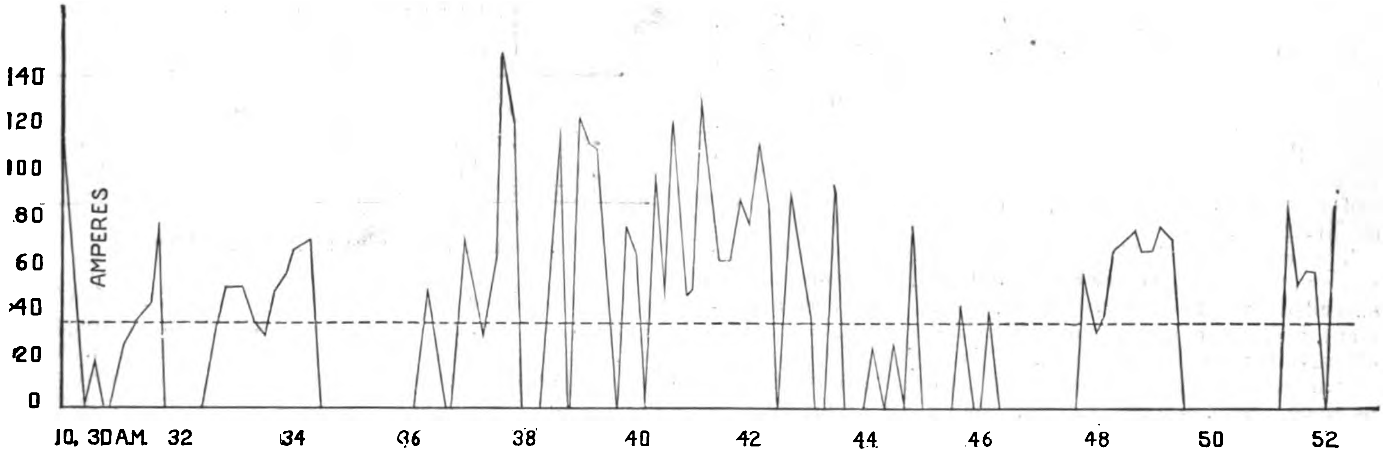
Vol. XIII. JUNE 29, 1892. No. 217.

POINTS ON POWER STATIONS.

BY

Wm Lee Church

BEAR in mind that the engine in an electric railway power station is normally an under-loaded engine,—not an over-loaded engine. That the above statement is not in still larger type is wholly the fault of the printer, and not of the emphasis which the writer desires to give it. Strange to say, a belief precisely the opposite of this seems to be floating vaguely in the minds of most railway men. It would seem somehow, that the abruptness of the load, and the momentary excess which is found every few minutes, had been confused in the mind so as to take the place of the working facts which exist. It is true that an electric railway engine gets frequent and heavy over-loads for an instant, but no more than ought to be comfortably taken care of by the fly-wheel and a proper steam distribution, provided the engine is intelligently adapted for the work. But this over-load has little *direct* bearing on the economy of the engine; in part, because the over-load lasts but a moment, and in still greater part, because a heavy load is, as a general statement, an economical load, within limits depending somewhat upon the type of engine. With reference, however, to the *fuel duty* of the engine, it is not the over-load which is to be principally considered, but the variations of load; and of these variations the minimum load plays by far the greater part in the final economy.



Load Diagram of Electric Railway Power Station.

To put the matter in another light we would say, that the maximum load determines the size of the engine, and the minimum load determines its duty. At this point the investigator is likely to jump to the false conclusion that the *average load for the day* represents the true performance of the engine, upon which he can base his estimate of fuel consumption. This certainly seems reasonable, but nothing can be further from the truth. To make the point clear, we will have recourse to another ampere diagram taken from a small station operating a country line over numerous grades. In this diagram it will be observed that for fully 20 per cent. of the time, there is no load whatever on the engine, other than its own friction and that of the generator. At such times the cars are all for the moment on the down-grade, the circuits open, and the amperemeter at zero. This particular diagram is necessarily confined to a section of but few minutes' run, but the same action was continuous throughout the day. Now the *average* horse power for this run would reduce to the power represented by the dotted line equivalent to 30 h. p.; but this average of 30 h. p. resulted from a continuous fluctuation from 0 h. p. to 125 h. p., and out of this arise some pertinent questions.

Assume that you are about to equip a small power station, and that you are aware of the probable fluctuation of load. Sufficient experience is now available to make this assumption a reasonably safe one. For present purposes we will go to the extreme though not uncommon case, represented by the diagram, and assume that your maximum load will be 125 h. p. It is manifest that you are compelled to select an engine of a rating of certainly not less than 100 h. p. at the determined steam pressure, in order that it may pull over the high spots without sensible diminution of speed. Being limited by this rigid necessity, you next propose to estimate beforehand what your probable coal account will be, since the final statement of the operating account will contain this as a large item. Shall we reckon the fuel duty on the basis of the rating of the engine, say, 100 h. p.? Manifestly not; because the engine gets no chance to work at its rated horse power except at brief and infrequent intervals. Shall we reckon the duty of the engine on the basis of the average of its power throughout the day, as per the dotted lines? Assuredly not; and let us see why. If you jump to conclusions again, you would figure something as follows: "My engine is a 100 h. p. engine, but it will average only 25 h. p. throughout the day. Now if it were running at its rated horse power it would consume, say, 25 lbs. of water per h. p. per hour. (It is assumed to be a compound non-condensing engine of the ordinary type not capable of meeting a fluctuating load.) But since it is operating at an average load of about 25 per cent. of its rating, I will allow that it will use as high as 30 lbs. of water per h. p. per hour; or a total of 13,500 lbs. of water, or, say, 1,350 lbs. of coal, or with banking fires about 1,500 lbs. of coal for an 18-hour run, equal, with $3 coal, to $2.25 per day; and this is what I will figure on in estimating my expense account." And in figuring this way, you would figure exactly wrong, and forever thereafter, you would wonder why you were burning so much coal. Moreover you would gently curse the engine under your breath. Now a matter of fact, *your power averages itself, but your fuel duty does not,* and this is what you never thought of.

Suppose we examine this point. A fuel duty under a continuous rated load, if your engine is a non-compound non-condensing engine of the slow speed variety, would be perhaps 28 lbs. of water, or as low as 25 lbs. with the ordinary compound engine; but even if the engine ran *continuously* at the average load of 25 h. p., its performance would be not better than 45 lbs. which will be fully demonstrated in another paper. Unfortunately, even this condition, bad as it is, almost never exists for more than a moment, but in fact the engine is alternately anywhere from 25 per cent. over-load down to no load at all, that is, no effective load. Under the rated load or thereabouts, you would be getting 25 to 28 lbs.; under a *continuous,* average load, if you had it, you might even get 40 lbs. But under the actual conditions of fluctuating load, out of which your average load is only *computed,* not *created,* you are getting anywhere from 30 to 75 lbs., and varying every moment. If you will now average the fluctuating duties due to the fluctuating loads, instead of averaging the load first, and then assuming a duty based on that, you will find that instead of 30 lbs. you will consume at least 50 lbs. of water per hour for every electrical horse power delivered. This means coal and dollars, and if you never knew it before, you will know it when you come to divide your coal bills by the car mileage. Perhaps I ought not to have taken so extreme a case, though an actual and common one, but all small stations suffer under these conditions, and the larger stations only modify them.

This condition of things, already bad enough, is further aggravated by the power required to drive a more or less extended line of counter-shafting, which power is a constant, and becomes a proportionately greater factor as the effective load becomes lighter. This subject, however, will be treated more fully in another article. The conditions outlined above, as has been said, are found in greatest intensity in the smaller class of stations, and on hilly roads, and to a certain extent become modified as the station becomes larger, the extremes of fluctuation being toned down by overlapping of a greater number of cars. The fluctuation is by no means reduced as much as is popularly supposed, and it is at present a question in the writer's mind whether 1,000 h. p. is not the smallest unit on the single-engine plan, which can with safety be considered in the hope of economical results. It is those small and moderate sized stations which the writer has most heavily on his mind; the big stations get the best attention and treatment, although, I humbly submit, not necessarily the best judgment. The smaller stations are apt to be tinkered up by home talent to save (?) money, or laid out in a general sort of hap-hazard style by some one more interested in the contract than in the engineering results. The fact of the matter is that the small station has the heaviest odds against it in respect to earning capacity any way, as is the general law with all small enterprises, from which it follows that it should, *per contra,* receive the most painstaking engineering in order to off-set this disadvantage and raise its intrinsic operative efficiency to the highest point. In short, give me the small stations and I care not who builds the big ones.

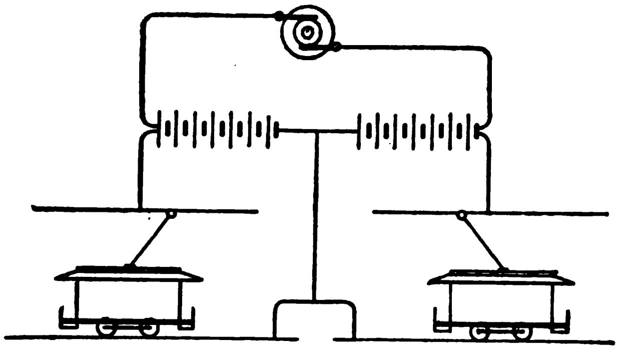
We therefore return to our original proposition and once more repeat that the engine in the power station of an electric railway is essentially an under-loaded engine, and not an over-loaded engine, and must be so treated. Having established this premise, the next and reasonable thing would be to examine the essentials of an engine capable of giving a high duty under light loads; or, more properly speaking, a uniformly high duty under all and wide variations of load. It has been well settled that no ordinary type of engine, compound or otherwise, can accomplish this desired result, even approximately, and since it has fallen in the writer's way to be connected with the development of certain improvements in precisely this direction, it will be the proper object for the next article to make the nature of these improvements somewhat plain.

STORAGE BATTERIES IN RAILWAY WORK.

BY

R. Macrae

The rapid development of electric street railway industries has given rise to the popular impression that in a short time electricity will entirely supersede steam as the motive power on steam railroads. A little study of the plans proposed for moving the trains in the Belt Line Tunnel at Baltimore, as far as they have been made public must, however, lead to the conclusion that present methods of operating electric railroads have to be very considerably modified before the manufacturer of steam locomotives will find his occupation gone. To get rid of smoke in the tunnel the trains are to be drawn through by two electric locomotives, developing about one-half the speed of the ordinary trains. To accomplish this it is proposed to erect a power generating station of 2,500 h. p. capacity. As the largest locomotives now used on the B. & O. R. R. are capable of developing but a little over 500 h. p. at a steam pressure of 150 lbs. it would appear that two steam locomotives of about 250 h. p. each would be sufficient to do the work that will require the erection of a power house of the above capacity when electric motors are employed. Allowing 85 per cent. as the efficiency of dynamos and conductors, 2,500 h. p. will produce a current of 3,245 amperes at a potential of 500 volts. To use such a large current without excessive loss in the conductors it will be necessary to locate the power house about midway between the two ends of the tunnel. This location will be in the neighborhood of the finest residences in Baltimore, and it is possible that the residents of this vicinity might prefer to have the smoke and cinders from two locomotives confined to the tunnel rather than to have the larger amount distributed above ground. With the aid of a few figures we will try to show that by using storage batteries this, and similar work, might be done at a much smaller first cost and in a more satisfactory manner.



STORAGE BATTERIES IN RAILWAY WORK.

The first and most obvious advantage of using storage batteries would be that the generating plant could be reduced from one capable of developing the maximum to one capable of developing only the average current required. With motors having the same relative torque as those now in general use the maximum current required in the case now considered, where only two motor units would be in use, would be at least four times as great as the average current necessary to do the work. This will, no doubt, explain why it is proposed to use a generating plant capable of developing power so much in excess of what at first sight might appear to be really necessary. Taking, then, the average current required at 25 per cent. of the maximum that can be generated by 2,500 h. p., and assuming that the motors would not be in actual motion more than eighteen hours out of twenty-four the average current used would be 3,245 (amps.) $\times .25 \times .75 = 608$ amperes. If we allow 80 per cent. for the efficiency of the battery, the charging current necessary would be 760 amperes at 500 volts This current could be supplied from a generating plant of 542 h. p. By using two sets of batteries connected in series, the charging current might be changed from 760 amperes at 500 volts to 380 amperes at 1,000 volts. The method of connecting up the batteries is shown in the accompanying diagram. The middle of the battery is connected to the earth or rails, and the two ends to the conductors, one over each track. This arrangement would secure all the advantages of a three-wire system without the necessity of using a third wire, at the same time making it impossible to receive a shock of over 500 volts by grounding any part of the system. In the case now considered, the batteries would be placed in recesses in the side of the tunnel, while the higher voltage used would render it practicable to locate the power house at a considerable distance, wherever it might be found most convenient.

The comparative cost of the two systems would be as follows :

2,500 h. p. plant, engines, smoke-stack, power house, etc., at $110 per h. p.	$275,000	500 cells, each weighing 966 pounds and capable of giving a maximum discharge of 1822 amperes, at 25 cts. per pound :	
	180,370	Battery	$120,750
		542 h. p. plant, etc.	59,620
Difference	$94,630		$180,370

This shows a saving in first cost of nearly $100,000 in favor of storage batteries. In estimating the weight of battery necessary, we have taken as a basis the weight and maximum discharge rate of the cells that are at present, and have for many months, been operating successfully one of the storage battery roads in this country.

As the weight of the battery is not so much a consideration in stationary work as the durability of the positive plate, 25 per cent. has been added to the total weight in this estimate to allow the metallic support in the positive plate to be made twice as heavy as that in the portable cells now made. No allowance has been made for the fact that on account of the battery receiving a constant current from the charging circuit the demand upon it would never be more than 75 per cent. of what it would be if used on a car.

As the manufacturer of lead batteries does not require either expensive machinery or skilled labor, the above figures would, we think, allow a fair profit to all concerned. The depreciation of a lead battery is simply the cost of labor in reconstructing the positive plate. The commercial value of the oxide formed by the oxidation of the positive support is somewhat greater than that of the metallic lead necessary to replace it. The oxide can be used over again indefinitely. For stationary work, with ordinary attention, the annual depreciation ought to be less than 10 per cent. The saving in fuel and the diminution in the wear and tear that would result from operating a small generating plant at a constant load, and at its best efficiency, with the advantage of being able at any time to shut down, would more than offset the loss and depreciation in the battery.

In the above estimate we have included the cost of a generating station, but in this case the erection of a power house would not be really necessary. Within a radius of one-half a mile from the tunnel there are four lighting stations with an aggregate generating capacity of over 2,100 h. p. The demand on this power for lighting does not exceed, in the busiest season, an average for the 24 hours of 1,000 h. p., leaving a balance of 1,100 h. p., that could be used for other purposes. After deducting 542 h. p. for moving the train in the tunnel, there would still remain 558 h. p. With batteries located at proper centres of distribution, this power would be sufficient to operate a street railway of 50 cars. Any direct current lighting dynamo could be utilized for generating a 1,000-volt current. Arc light machines might be joined in parallel and incandescent machines in series. If necessary or convenient the batteries might receive current from different stations, payment for the same being made by meter.

By the use of storage batteries located at different points along the route and charged in this way, electric railways could economically encroach more and more on the domain of steam railroads. Natural sources of power, such as waterfalls, would become much more available for the type of railway motors now used, and the dynamos in lighting stations could be kept in almost constant service instead of being allowed, as at present, to sleep all the summer day under canvas covers.

NEW FAN MOTOR OF THE INTERIOR CONDUIT AND INSULATION COMPANY.

Now that the warm weather is upon us, it is a fitting time to make note of the various improvements that have been recently made in fan motors, which add so much to our comfort during the warm summer months. The Interior Conduit and Insulation Company, of New York, are bringing out an entirely new form of fan motor, the invention of Mr. Robert Lundell who is connected with the company.

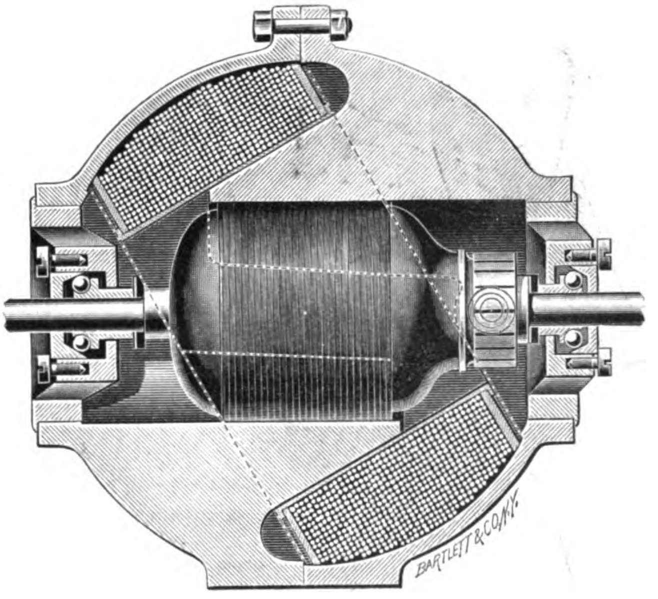


FIG. 1.—LUNDELL IRON-CLAD FAN MOTOR.

Many attempts have been made to design small dynamos and motors in which there should be practically no magnetic leakage, but in the usual types of motor the leakage frequently amounts to from 40 to 50 per cent. thus requiring an extra heavy magnetic circuit and producing a field magnet of low efficiency. The practical elimination of all magnetic leakage constitutes the chief factor of efficiency in the new Lundell motor, although it is not the only one.

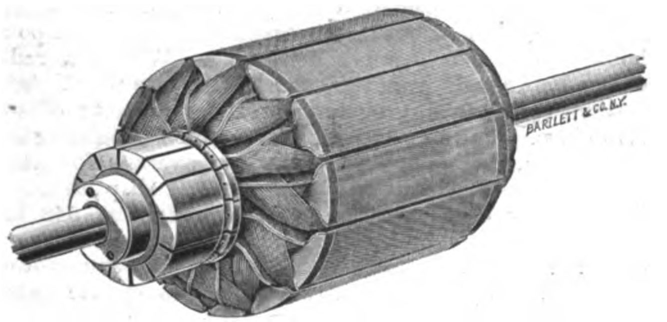

BARTLETT & CO. N.Y.

Fig. 2.—Armature of Lundell Fan Motor.

This great desideratum is attained in the manner shown in Fig. 1. As will be seen the armature and pole-pieces are surrounded by a single magnetizing coil, which, in turn, is itself totally surrounded by the keeper or yoke, thus leaving no chance for stray magnetism. It is a true iron-clad field magnet, having at the same time the shortest possible magnetic circuit. The keeper would form a perfect sphere were it not for the slight projections constituting the bearings.

The motor assumes wonderfully small dimensions for any given capacity, due to the fact that every cubic inch of space inside the spherical keeper is effectively utilized. It is also very light on account of a short magnetic circuit having the smallest possible cross-section, with comparatively few turns of wire in the magnetizing coil.

The type of armature adopted, as shown in Fig. 2, is a modern Pacinotti drum, proportioned with a view to maximum efficiency. In the design of the motor particular attention has been paid to the shape of the pole-pieces in relation to the reaction between armature and field magnet.

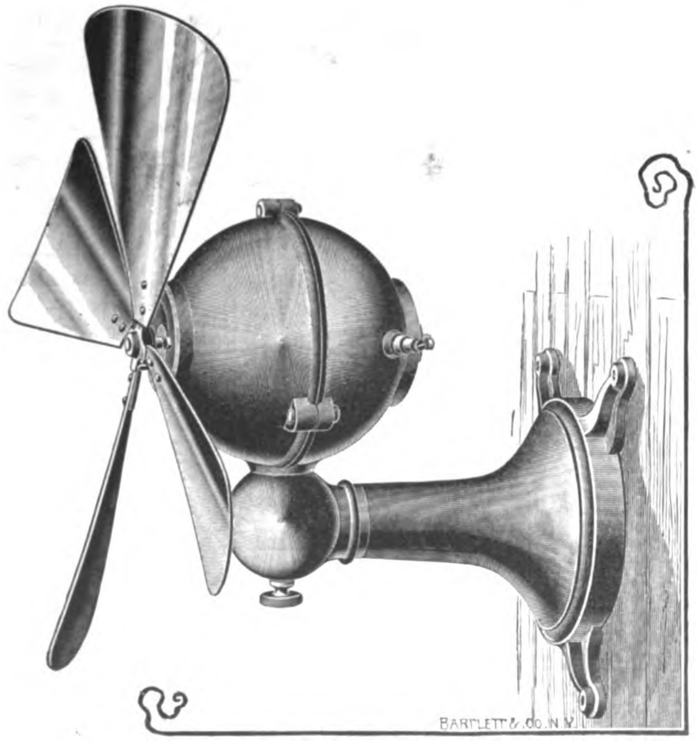

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Fig. 4.—Bracket Fan Motor.

Thus the motor has been rendered sparkless, and the point of commutation remains fixed between the limits of load and at reversal of rotation. The need for a special rocker-arm for supporting and adjusting the brushes is consequently obviated. The brushes themselves are small carbon pencils, fitted in bayonet-jointed holders, and held upon the commutator by a small spiral spring.

The new motors are furnished in five different styles, the engraving Fig. 3 showing the regular desk fan with wire screen. Fig. 4 illustrates the bracket fan motor and demonstrates the ready adaptability of the motor to be placed in almost any position. By means of a neat suspension chain the motor can also be readily hung from the ceiling and with equal facility set to drive a vertical ceiling fan.

The $\frac{1}{12}$ h. p. motors are all fitted with ball bearings which require no oil, a most valuable consideration. They run at a maximum speed of 1,800 revolutions per minute, a minimum speed of 900 and a mean speed of 1,150 at 110 volts E. M. F.; while the $\frac{1}{8}$ h. p. motors have a maximum speed of 1,800 revolutions, a minimum speed of 900 and a mean speed of 1,000 revolutions per minute.

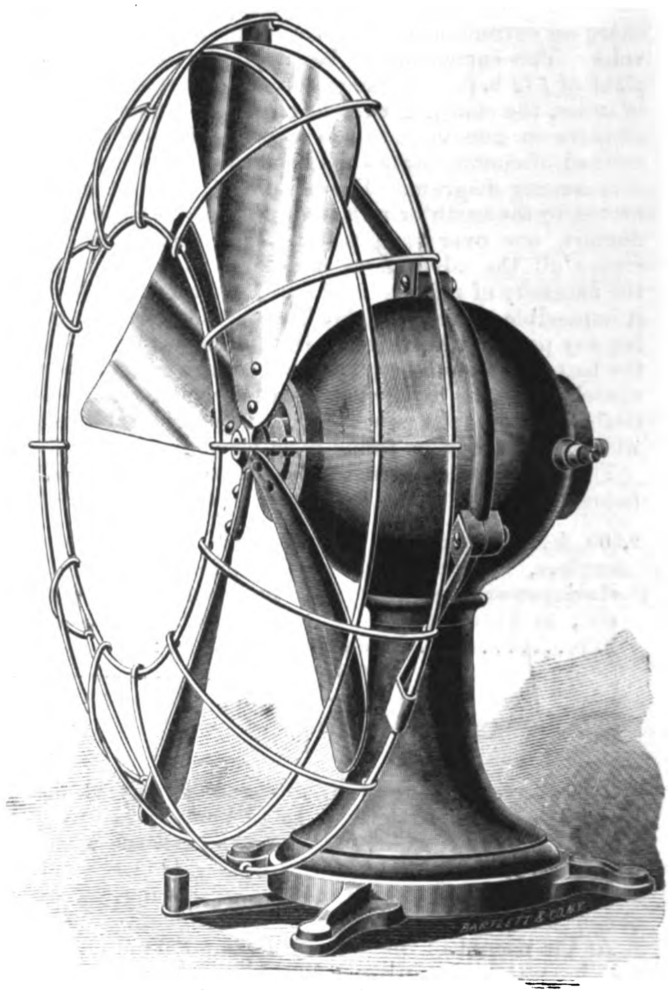
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Fig. 3.—Desk Fan Motor.

ELECTRIC CRANES FOR THE WORLD'S FAIR.

Visitors to Machinery Hall will be enabled to pass from one end of the building to the other at an elevation, and thus gain a bird's-eye view of the vast area of exhibits, and to see many of the larger exhibits to much greater advantage than will be possible from the floor. To accomplish this three mammoth electric traveling cranes will be constructed, each with a lifting and carrying capacity of 40,000 pounds. Contracts for their construction have been let to the Yale & Towne Manufacturing Company of Stamford, Conn., the Morgan Engineering Company of Alliance, Ohio, and the Edge Moor Bridge Works of Wilmington, Del.

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EDITORIAL ANNOUNCEMENTS.

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Communications *suitable for our columns will be welcomed from any quarter. Discussions of subjects relating to all branches of electro-technical work, by persons practically acquainted with them are especially desired. Unavailable and rejected manuscripts will be returned only when accompanied by the necessary postage.*

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It is doubtful if any great truth has ever been lost; though some may have apparently lain dormant for a time, yet they have continually produced results.—Joseph Henry.

CONFLICTING ASPECTS OF LAMP LITIGATION.

THE decision of Judge Acheson, in the suit of the United States Electric Lighting Company against the Edison Lamp Company for alleged infringement of Weston's patent for hydrocarbon treatment of carbon burners for incandescent lamps, an abstract of which we publish in another column, may or may not mark an important epoch in the history of incandescent lamp litigation, but it will certainly have the effect of raising some decidedly interesting and important legal questions. Judge Acheson holds that the public exhibition by Sawyer and Man of a "large number of incandescent lamps" containing treated or flashed carbons, between March, 1878, and May, 1879, was "a practical and public use." This, it will be noted, was some time prior to any attempt by Edison to make use of carbon. Sawyer and Man took out two United States patents, and at least one British patent, covering their invention of hydrocarbon treatment. The British patent, known as the "Cheesbrough," of November 28, 1878, was fully sustained by the highest courts of that country, after protracted litigation, its principal claim being for the "method of preparing the illuminating portion of an electric lamp, consisting of electrically heating the same while it is surrounded by a carbon gas or liquid." The first domestic patent (No. 211,262), dated January 7, 1879, was similar to the British patent, except that the process claimed was, for some unexplained reason, limited to immersion in hydrocarbon "liquid." After the issue of this patent, the United States Electric Lighting Company filed a conflicting application, claiming priority of invention in behalf of Edward Weston, making substantially the same claim as that of the above-mentioned British patent, and ultimately succeeded in securing the patent which has now been pronounced invalid by Judge Acheson. The present adjudication is, therefore, in effect, an affirmation of the validity of the Sawyer and Man patent. Moreover, on November 29, 1878, Sawyer and Man obtained a second patent covering an electric burner of carbon "consolidated and purified by electrical treatment in combination with a carbonaceous substance," which, of course, embraces treatment by gaseous as well as liquid hydrocarbons. But it will be noted that both these patents were issued, and one of them was applied for, subsequent to the date of the British patent for the same invention, which circumstance still further complicates the legal situation. Both of these Sawyer and Man patents, as well as the discredited Weston patent, are now controlled by the Westinghouse Company, a fact which is the more interesting to lamp manufacturers, inasmuch as nearly all the incandescent lamps now made contain carbons which have been treated by the hydrocarbon process. Another point of interest in connection with Judge Acheson's decision is, that the finding is directly contrary to that of the late Judge Bradley, in the McKeesport fibrous-carbon case, who, upon precisely the same evidences of fact, held that the work of Sawyer and Man was not a "practical and public use," and hence did not anticipate Edison's subsequent discoveries. In short, it looks very much as if the prospect of a final settlement of the legal status of the incandescent lamp, in view of this decision, was farther off than ever.

GROUNDING THE NEUTRAL.

Insurance bodies, especially those in New York, have of late made considerable ado over the practice pursued by the local Edison Company in this city in grounding the neutral on their three-wire system. While those opposed to this practice point out the dangers arising from a permanent ground on any electric system, the advocates of the method of grounding contend that by the practice pursued the entire system is relieved of one-half the strain on the insulation, and that hence the liability to leakage is reduced just to that extent. It has been generally supposed that the practice of grounding the neutral was only practiced in this country and in a few isolated cases, but that it is practiced abroad, by reputable firms, will be somewhat of a surprise to the opponents of this method. In a recent number of the *Elektrotechnische Zeitschrift* we note that the well-known firm of Schuckert & Co., of Nuremberg, employed the grounded neutral in their installation at the Frankfort Exhibition, and that the station put in by them at Altona near Hamburg is now operated on a like plan. They also draw attention to the fact that the uninsulated conductors laid in the ground in the immediate neighborhood of telephone and telegraph offices gave rise to no complaint. The same practice appears to be in vogue in Athens, but the only difficulty there encountered is due to the fact that the lead armor with which the conductors were covered was employed as the return neutral in contact with the earth; hence electrolytic action set in which destroyed the lead covering. Where such a covering is not employed, however, it is apparent that the difficulties in this respect would not be encountered. We have deemed it well to call attention to foreign practice in this respect, in order to show that electrical engineers abroad have also recognized that the grounded neutral possessses advantages, and that if properly carried out it is not as dangerous a plan as some would have us believe it is.

STORAGE BATTERIES IN RAILWAY WORK.

While the storage battery as applied to electric railway work has heretofore been considered almost exclusively from the standpoint of its application directly to the cars to be driven, but little attention has apparently been bestowed upon the method of its utilization in the power station itself. It goes without saying that in electric railway work, for the most part, large fluctuations in power will be encountered, and if by any means the economy of operation can be increased, all means to that end ought to be applied. In considering the application of electric locomotives to the propulsion of trains through the Baltimore tunnel, Mr. Macrae, in this issue, argues that by the use of storage batteries better results would be obtained than by the application of the current direct. Mr. Macrae's figures, it is true, are only approximate and based on the assumption that the difference between the mean and a maximum load would be as great, in the case considered, as in the ordinary electric road operating only two cars. Until the detailed amount of traffic passing through the tunnel is known, it would be hardly practicable to form an intelligent judgment as to which plan would be the better, but the suggestion of Mr. Macrae appears to be worthy of respectful study.

UNDERGROUND ELECTRIC RAILWAYS.

The commissioners appointed by the General Term of the Supreme Court to decide whether the railroads proposed by the Rapid Transit Commissioners may be constructed according to the plans and specifications of those commissioners, such decision to be in lieu of the consents of the abutting property-owners, have decided broadly in favor of the scheme laid out. The plan recommended is practically an underground road from the Battery to Fifty-ninth street and to One Hundred and Twenty-first street, and thence to city limits by viaduct or underground structure. There is also included an east-side line up to Forty-fourth street, from Fourteenth, and a loop down town around City Hall Park. In regard to the motive power, the commissioners declare that electricity can be used, and that the conclusion has been arrived at after consultation with experts. The commissioners further express their belief that capital will be readily forthcoming for the enterprise. Argument is to be heard on June 29 as to the acceptance of this report.

It is significant that while an American body has thus been deciding again in favor of underground electric traction, an English body of even more importance and influence has placed itself on record in similar terms. A joint committee of the two British Houses of Parliament, having under consideration the numerous plans for extending the underground electric railway service of London, in which it is proposed to expend several millions of dollars, has expressed its opinion in favor of the underground system, and also reports that the evidence as to the adequacy and reliability of electricity is convincing. Even should New York still be denied the rapid transit facilities it so badly needs, London bids fair to enjoy soon an underground electric system of proportions fully equal to those of the old steam tunnel system, now admitted to be behind the march of improvement and the demands of the day. But there is no good reason why New York should lag behind in any respect of modern convenience and advantage. In fact, of the two cities, New York has probably the inferior facilities at the present time, owing to the restriction of travel in the busy hours to a single direction; so that even a small measure of relief, enough to keep pace with the mere normal rate of increase, would be welcome.

THE GROWTH OF THE THOMSON-HOUSTON COMCOMPANY.

We publish in this issue from the pen of Mr. A. C. Shaw an article of unusual interest, descriptive of the rise and growth of the Thomson-Houston Co., and of its present plant and processes. This company has gained its prominence through one of the rarest combinations of inventive genius, financial skill and executive ability that the world has ever seen, and it was fitting, that as it now merges into an even larger organization some note should be made in this manner, of its evolution. If success have any lessons for us, there must be much of instruction and suggestion in such a brilliant record as this. To us, one of the most striking features of the story is that the company made its humble beginnings at a time when it seemed as though the mighty competitors already in possession of the ground had pre-empted every opportunity of growth and prosperity. What encouragement lies in this fact for brains and capital embarking to-day in electrical enterprises! After all, in electricity, the greater does not lie behind, but beyond.

An "I Am Sir Oracle" on Electric Railways.

One of the most persistent opponents of the trolley system for Brooklyn and New York has been Mr. David M. Stone, the venerable editor of the *Journal of Commerce*. That he knows what he is talking about may be inferred from the subjoined passage, which appears in one of his articles under date of June 20: "It will never be safe to ride in a trolley car while the present system is used. The passengers cannot avoid the influence by induction of the electric current. *Palsy will be common* among the throng of those who will use these means of conveyance, and life's currents will be checked by the unseen agent so little understood but so recklessly employed." Such a case of ignorance as this is certainly hopeless. Evidently, the unseen agent is very "little understood" by some who would set themselves up as Sir Oracles. But for Mr. Stone's long years of public service, his language "so recklessly employed" would warrant about as severe a rebuke as could be given it.

"T.-H."; or Among the Dynamo Builders of Lynn.

BY

A. C. Shaw.

I.

UNTIL within the last ten years the town of Lynn, Mass., was but little known to any one outside of the shoe trade, in which business it had undoubtedly earned a wide reputation. It was little thought at that time that it would become the home of so large an electrical industry as that represented by the Thomson-Houston Electric Company. Now, it would be safe to say, not only is there no one who is interested in the smallest way in electrical pursuits who has not heard of Lynn, but there are few who have ever had the opportunity who have not visited this town which contains, probably, the largest electrical industry in the world. It will, therefore, be a matter of universal interest to present to our readers a description of the factories of the Thomson-Houston Company, with a few brief notes of their methods of manufacture and some description of the various goods which are daily being turned out for shipment to all parts of the world in this busy town on the coast of Massachusetts.

II.

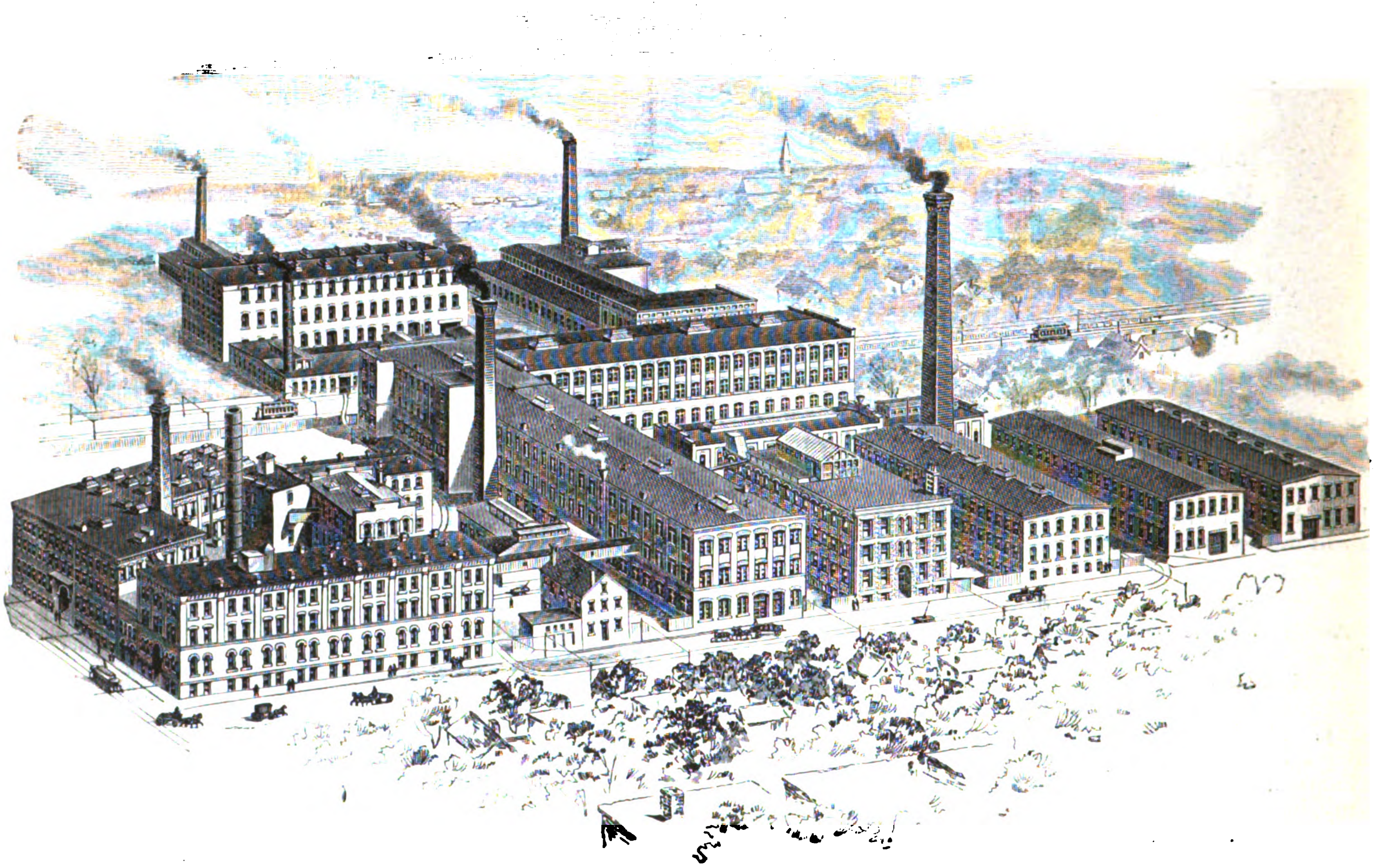
Among the manufacturers of the larger and heavier classes of electrical apparatus in this country, there is probably no company whose history contains so unbroken a record of successes as that of the Thomson-Houston Company. Much of this is naturally due to the inventive genius of the founder of the industry, Professor Elihu Thomson, but the wonderful business success of the company, in its growth from a small manufacturing concern in New Britain, Conn., with a paid up capital of only $87,500 to the gigantic organization of to-day, with its capital of $18,400,000, is undoubtedly the result of the brilliant financial management of Mr. C. A. Coffin, the general manager of the company, and the living mainspring of the whole concern. The Thomson-Houston Company was originally formed in 1880 in New Britain, under the name of the American Electric Company, to manufacture arc-light dynamos from the designs of Prof. Elihu Thomson and Prof. E. J. Houston, who had previously successfully built an eight-light dynamo with automatic regulator in a small shop in Philadelphia. The newly organized company secured the old Stanley works for their factory, and struggled along for the first two years very slowly, but overcoming many difficulties, and laying a solid foundation of valuable experience and good patents. In the early part of 1882 the majority of the stock fell into the hands of the president of the Brush Company, who, however, in the fall of the same year, having made no endeavor to push the business, allowed it to lapse into the hands of certain Lynn capitalists. These gentlemen, headed by Mr. H. A. Pevear, S. A. Barton and C. A. Coffin, immediately reorganized the business on an active basis, and changed the name of the company to the Thomson-Houston Electric Company, obtaining a charter previously granted under the laws of Connecticut, with a capital of $87,500. The business was still carried on at New Britain, but preparations were early made to transfer the factory to Lynn, and a building having been erected in that city on Western avenue and Federal street, the removal of the machinery took place in the fall of 1883, and we present a picture on this page of the factory as it appeared in 1884, and which is now used as factory A, shown in the plan. Since that time the business has gone on steadily increasing, and new branches have been constantly added, including the direct incandescent, alternating incandescent, motor and railway work, and lastly the mining department. As the business increased the factory facilities were naturally increased, until from the original floor space of 26,962 square feet, they now occupy 342,000 square feet, or about eight acres. In the same way the number of operatives in January, 1883, was only 45, while in January, 1892, they were 3,492, and at the present time there are more than 4,000. On July 22, 1880, the capital stock was increased to $125,000; on May 24, 1887, it was increased to $500,000; and on March 8, 1888 it was increased to $1,000,000. It ultimately reached $18,400,000, and, at that stage, merged with the Edison General Electric Co., with which it will now constitute the General Electric Co.

THE OLD THOMSON-HOUSTON FACTORY AT LYNN, 1884.

III.

To assist our readers we show on page 658 a plan of the factories as they stand at the present time, each one of which is known by a letter of the alphabet and so designated on the plan.

In describing the numerous departments of the factories, it is natural to commence, with the large machine-shop designated first L, in the plan, where all the large castings are received, and undergo their first treatment. Up to the present the Thomson-Houston Company have had no foundry of their own, but have had all their iron castings made outside, though arrangements are now being perfected whereby they will run their own foundry, and thus be enabled to produce a finished machine from the rough pig iron, to the completed dynamo ready to be set up in its appointed place. This machine-shop shown in our engraving on page 649 is a large well-lighted room, measuring 75 feet by 187 feet, and occupies two stories of factory L, with a gallery at either side, used for winding armatures. Heavy machine tools are arranged along either side, and the fitting together of the parts is done in the middle of the shop. The shafting for this shop is all run by railway motors, of which there are five situated in convenient places. The machine, tools consist of heavy planing machines, lathes, drills, special machines for boring the inside of the pole-pieces of the various classes of dynamo, and some special machinery for boring the large 670 h. p. M. P. 500-volt railway generators. Here may be seen all kinds of dynamos and generators in their initial state, and it is interesting to see the easy way in which the parts of these large electrical monsters are prepared for being ultimately fitted together, some having their flanges planed, some having holes bored for fitting together, and others in a more finished state having been bolted together, having their pole-pieces bored out, and their rough edges dressed down. Overhead, running on rails on a level with the gallery, is a huge 30-ton traveling crane, manufactured by the Morgan Engineering Company of Alliance, O., and operated by three T. H. motors, so that it has three simultaneous movements, being able to move along the length of the shop, raise or lower its load, and at the same time move it across the breadth of the shop. By means of this crane every inch of floor space is made available and the utmost economy in handling the heavy castings is attained. In addition to the crane, there is also a track leading through the middle of the shop, on which castings can be transported from one part of the factory to any other on motor trucks.



BIRD'S EYE VIEW OF THE THOMSON-HOUSTON ELECTRIC CO.'S FACTORIES, LYNN, MASS.

Passing into the adjoining factory C on the same floor, we reach another huge machine-shop, which is devoted chiefly to the machining of the railway motors, of which a multitude can be distinctly seen in our illustration on page 650 stacked up in rows, either awaiting their turn to be planed and bored, or finished ready to be moved on to the next process. In this room there is a huge array of planing machines, shown on page 651, each one capable of planing four W. P. motors at one time, and at the further end is situated a forest of drilling machines, which bore the necessary holes for bolts and other purposes. In this shop also the fields of the W. P. motor are bored, and the bearings are all fitted with brasses, the present capacity of the shop being 150 W. P. motors per week. In one corner of this shop may also be seen a number of men busy building up the armature cores from the soft laminated iron, and some half dozen very ingenious machines working hard cleaning out the slots in the iron-clad armature cores, so as to leave them perfectly smooth for the winders.

IV.

Passing up stairs in this building we come to second C, in which there are a number of different operations going on. The end near factory L is devoted to assembling the railway motors, putting on the field spools, inserting the armature, and then submitting them to a crucial working test, by gearing them to one another in such a way that one motor is run as a receiver, while the other is made to work as a generator. In another part of this room also the assembling and testing of the smaller generators take place, it being devoted to alternating dynamos, railway generators and direct current incandescent dynamos of the motor type up to about 100 h. p. The spool winding for the motors is also done on this floor, and a large number of men are kept in constant work on this operation. The further end of this room is devoted entirely to the testing of transformers of all sizes. These are arranged on shelves around a small apartment, carefully partitioned off from the rest of the room, and have to stand a test of several hours under full load. Each converter is also tested up to 5,000 volts before being filled with oil and sealed up, by means of a transformer having a range up to 10,000 volts. Here also the accommodating attendant will be glad to demagnetize the visitor's watch, should it have become magnetized, by inserting it in a coil of wire, in which the alternating current is flowing, attaching it to a string, revolving it rapidly, and gradually withdrawing it from the influence of the magnetic circuit.

Machine Shop in Factory "L" for Handling Heavy Work.

Passing up stairs again into the third floor of factory C, we come first to the manufacture of transformers. Here the laminated iron cores are pressed together by the machine shown in the accompanying cut on page 652, and the spools of the primary and secondary circuits, which are also wound on this floor, inserted in place, after being carefully insulated. Further along may be seen the manufacture of switches and resistance boxes, with all their accompanying parts of slate bases, insulated handles, German silver resistance coils, and other details. The remaining third of this floor is entirely devoted to the manufacture of commutators, and we present a view of this interesting process in the accompanying engraving, page 652. Here may be seen commutators in all stages of manufacture, one man trueing up the segments, before putting them together, another inserting them in two iron bands with innumerable screws for compressing them into the desired size, and insulating them with mica, while others are busily engaged turning them down, and fitting on collars or end plates for holding them in their true position. Here also may be seen commutators of all sizes, from a small one of three inches in diameter to the largest commutator for the 670 h. p. generators measuring 25 inches diameter, composed of 180 segments and weighing, when completed 1,950 pounds.

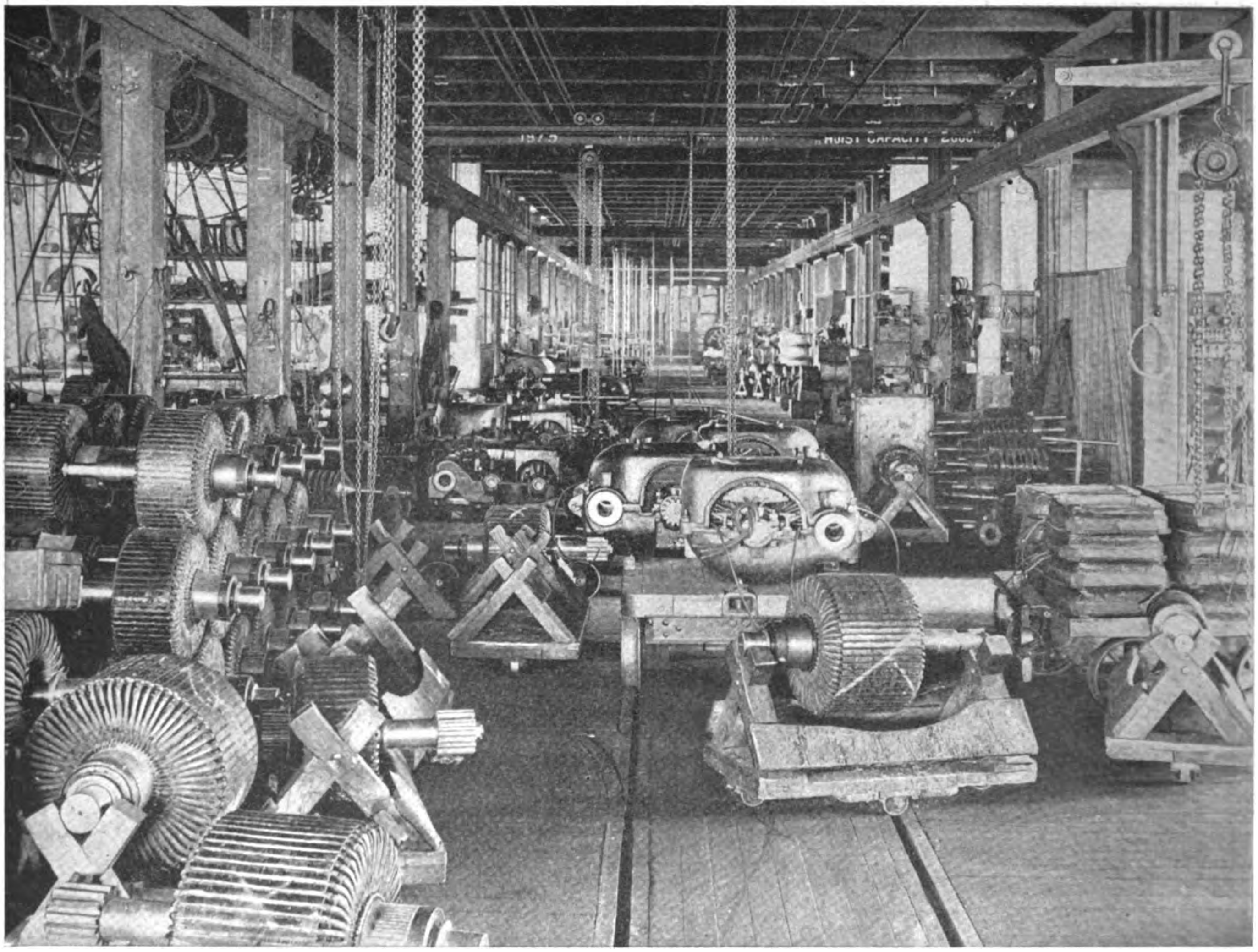
V.

Leaving factory C and returning to factory L on the second floor, or rather the galleries of the large machine-shop, already mentioned, we arrive at the armature winding department, which appears at first sight to be the busiest scene in the whole factory.

Standing at the door and looking down the length of one of these galleries, are seen a veritable army of men all engaged in winding railway motor armatures. Over 400 men are employed in these two galleries all busily engaged in winding the armatures which are arranged on each gallery in four long rows, with two men at each armature. The one gallery is entirely devoted to railway motor armatures, while the other contains a number of armatures for various purposes and of various design, W. P. railway, S. R. G. railway, alternating and drum type for incandescent work.

At the end of this hall there is a small communicating gallery from which our view of the machine-shop is taken, and from which can be seen at one time over 400 men at work.

Passing again up stairs on to the third floor we reach another machine-shop, shown on page 653, filled with a lighter class of tools than those in the other machine-shops. Here all the pinions for the railway gears are made, being cut out by gear cutting machines from solid steel forgings. The dust-proof oil cases for enclosing the gears are also made on this floor, together with the self-oiling boxes, for the bearings, which form a particular feature of all Thomson-Houston machines. Bearings, light shafting, key seating and a host of similar work is also in full progress on this floor, while the small motors up to 15 h. p. are here assembled, afterwards being taken to second C for testing before shipment.



Machine Shop for Finishing Railway Motors, Factory "C."

VI.

Having thus completed our visit to factories C and L, we now pass on to factory A, and find ourselves in the region of the well known familiar arc light machines. On the second floor as represented on page 652 a number of men are employed in winding the coils for the spherical armatures, so well known that they need no description. In another part of this room, the heavy spools for the field magnets of the heavy railway generators are being wound, while in a corner by themselves the small magnets for arc lamps are being wound by the hundred.

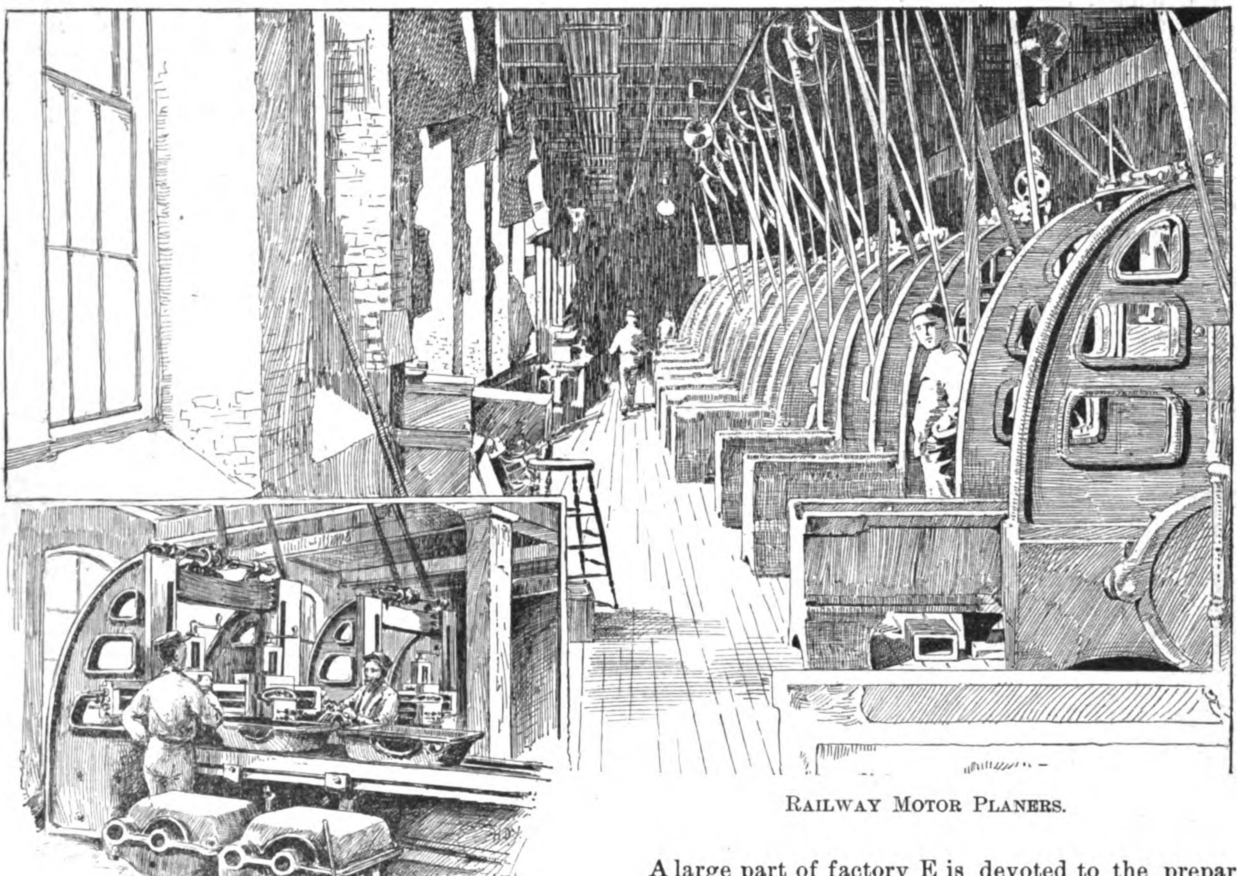
The first floor of this building is devoted to the assembling of arc lamps, and in boxes and other receptacles are seen thousands of parts of the well-known type of Thomson-Rice arc lamp. Accommodation is also here provided for a large stock-room, while another part of the floor is devoted to the manufacture of the innumerable small special tools used in the manufacture of the various electrical apparatus in the different shops.

The third floor of A is devoted entirely to the manufacture of incandescent lamps of various candle powers and voltages. In another part of the factory a number of boys are engaged in unpacking the glass as it comes from the glass works, cleaning it out and sorting it into various portable rack trays by which it is conveyed to the men who afterwards fashion it into the necesary shape for receiving the filament. The glass blowers, working at benches, upon which the necessary blow pipes are mounted as shown in our picture on page 654, first take the glass bulb, open up the round end and carefully seal in the exhausting stem. At the other end of the room are arranged several rows of girls all busily engaged in sealing in the already prepared filament after having cut the globe to the proper length, and preparing the lamp for the process of exhaustion which is done in another part of the factory. This floor makes a very pretty and interesting scene, and it is extremely fascinating to watch the expert fingers of the girls as they deftly fit the two parts of the lamp together, apply the flame, expertly spin the lamp around and in a few minutes lay it aside on the waiting rack to be carefully carried away to the exhausting-room. Small vari-colored seals are also pasted on to the lamps, each seal denoting a different voltage or candle power, and preventing any chance of mistake after completion.

VII.

Passing into factory B, on the second floor we reach a large room also devoted to the manufacture of incandescent lamps. At the north end of this room is a large stockroom from which the daily shipments are made. Next to this are the large racks on which the finished lamps are tested, the lamps all being screwed on to the standard sockets by boys who work on piece-work, and who have got so expert by experience that they can insert five lamps in about the time it would take any ordinary person to insert one. In the other half of the room about 30 girls are employed fitting the lamps with collars, as shown in the illustration on page 652. These collars are filled with plaster of paris, and the connecting wires are led through and soldered to the collar. The lamps are then washed and passed into the photometer-room, which stands in a corner by itself and which is entirely secluded from the other parts of the room. The photometric system employed here is very complete, and the process is extremely interesting. The lamps are mounted on a revolving circular frame, which contains five lamps at one time, and alongside is the standard lamp from which by comparison the measurements are taken. As soon as the lamps are connected they are illuminated by a current the voltage of which can be changed by rheostats under the control of the girl who compares the shadows on the photometer with the shadow of the standard lamp. The work is done on piece-work and is conducted in a marvelously expeditious manner. One girl attends to the revolving frame, putting in new lamps, and taking care of the lamps measured and marked. A second girl reads the voltmeter at the moment the shadows are announced to be alike. A third girl marks the lamp with the exact voltage, while a fourth girl measures the shadows and handles the rheostats. As the measuring by shadows is apt to be rather trying on the eyes, the order of things is reversed after measuring each tray of lamps.

The pump-room for exhausting the lamps is situated on the floor above, and contains several hundred of both Geissler and Sprengel pumps, having a united capacity for exhausting 5,000 lamps a day. The Packard vacuum pumps for creating the vacuum necessary to operate the mercury pumps are situated in the basement of the building, and are also used as usual for the preliminary exhaustion. There is used in this pumping-room about 15,000 pounds of mercury to operate the various mercurial pumps, which gives some idea of the magnitude of the work here carried on in the manufacture of incandescent lamps.



RAILWAY MOTOR PLANERS.

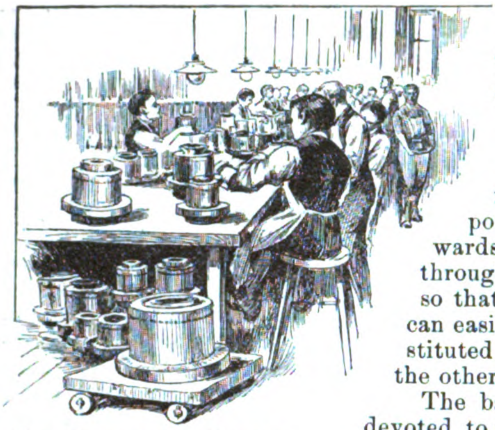
PLANING RAILWAY MOTOR CASINGS.

A large part of factory E is devoted to the preparation of the carbon filament and many of the methods are original and have been carefully worked out. Some 65 or 70 girls and boys are employed on this work.

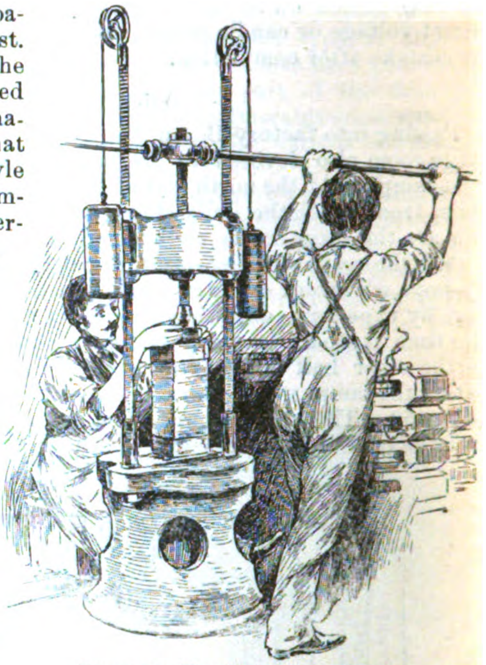
VIII.

Passing on in factory B, on the second floor we reach the department shown on page 652, devoted to the testing of arc lamps, a sight which at first is rather trying to the eyes, as the racks from which the lamps are suspended can accommodate about 170 lamps, which produce an amount of light not altogether comfortable. Further along there is situated a number of light machine tools for the manufacture of the small parts of the arc lamps, while arc lamp switchboards, fuse boxes, magnetic cut-outs and lightning arresters are also made on this floor.

The basement of factory B, is largely devoted to the testing of incandescent dynamos of the spherical armature type. A Corliss engine is provided for this purpose fitted up with every convenience for telling the horse power consumed, while there are all kinds of instruments for ascer-



The Commutator Department.

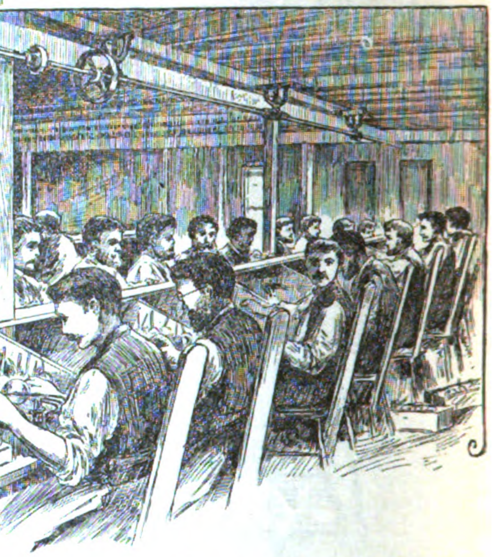


Pressing Transformer Cores.

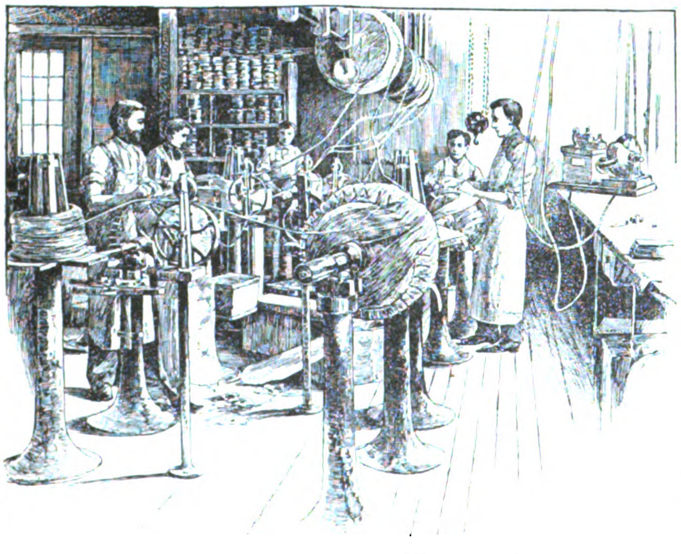
taining the exact voltage and capacity of the dynamos under test. The new type of armature for the arc light dynamos is also assembled on this floor. This form of armature does away with the somewhat complicated winding in the old style machine, the winding being composed of 30 small coils which are afterwards slipped on to the armature, through a specially prepared opening, so that any coil, should it burn out, can easily be removed and another substituted without affecting in any way the other coils.

The basement of factory A is chiefly devoted to the manufacture and testing of arc light dynamos as well as the manufacture of the frames for the spherical type of dynamos, and the building up of armature cores. All the spherical dynamos are assembled in this shop, while the adjoining basement of factory E is devoted to the building and turning of armature cores.

Leaving factory A, we next arrive at factory I, which has two floors entirely devoted to carpenter work, in which the hanger-boards for the arc lamps, switch and fuse boxes, and all the woodwork necessary on electrical apparatus is made. This shop is well supplied with circular saws, band-saws, planing machines, milling machines and all the necessary machinery for this purpose. Here also the patterns for the various castings are made, from which they are sent to foundries in the vicinity.



In the Incandescent Lamp Department.

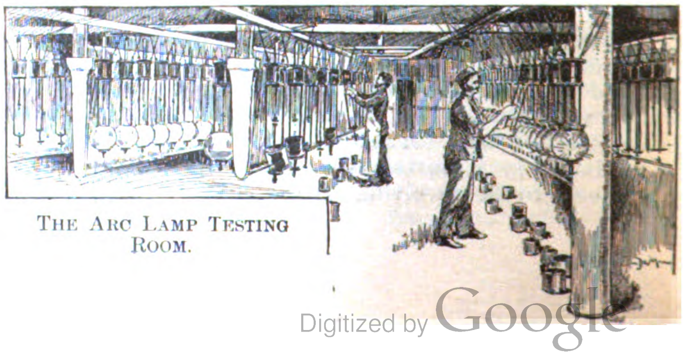


A Corner in the Arc Armature Winding Department.

IX

Factory J presents a very busy scene and is chiefly occupied by girls who are engaged in splitting and gauging mica used in the insulating of the commutators. The mica is received in barrels and is first sorted out by men who pass it on to the girls to be split up. A large number of girls are employed in this work and there are consumed in this room a large number of barrels a week. The mica is afterwards stamped out into the desired shape, and then tied in bundles and distributed to the various departments where it is used. Mica scrap is also used in the insulation of the large armatures, being pasted onto strong canvas and then cut up into long strips. One end of this room is devoted to tinsmith work, where all the guards for arc lamps are manufactured, and all other tin and copper work used with Thomson-Houston apparatus.

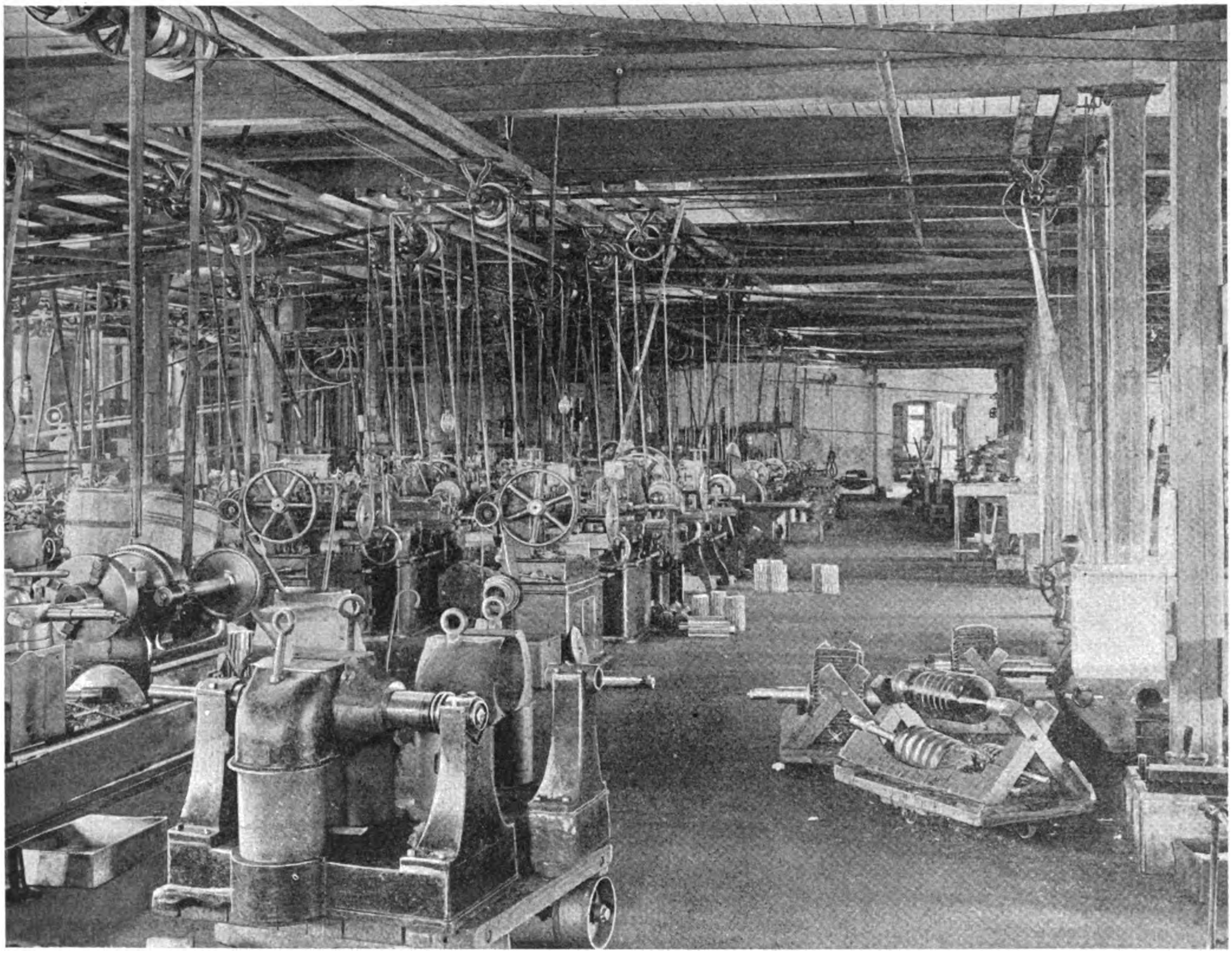
The first floor of factory J is devoted to the mining department, and here one can see electric drills, coal cutters, and various apparatus for mining work in all stages of completion. This department is kept strictly by itself, and all the necessary machinery for the manufacture of the



The Arc Lamp Testing Room.

various parts, together with the assembling, are in the one room.

Passing on we come to factory D, the second floor of which is devoted exclusively to the manufacture of the Thomson wattmeter, which has obtained so well-earned a reputation, and which is manufactured in very large numbers. The illustrations on page 654 show a few of the processes in this department, and the visitor will find in this room much that is of great interest, as the work is extremely fine and of the most exacting character. Girls are employed in this department for winding the tiny armatures, and it is curious to watch their swift moving fingers as they lightly wind the hair-like wire on the tiny cores, sort out the ends and solder them on to the commutators. The commutators are also put together on this floor, while men are busily engaged in assembling the frames, trueing the revolving copper plates, and finishing up the meter ready to be tested. This latter process is accomplished on the floor below, each meter being subjected to a time test and careful calibration before shipping.



MACHINE SHOP FOR FINISHING LIGHT WORK, FACTORY "L."

X.

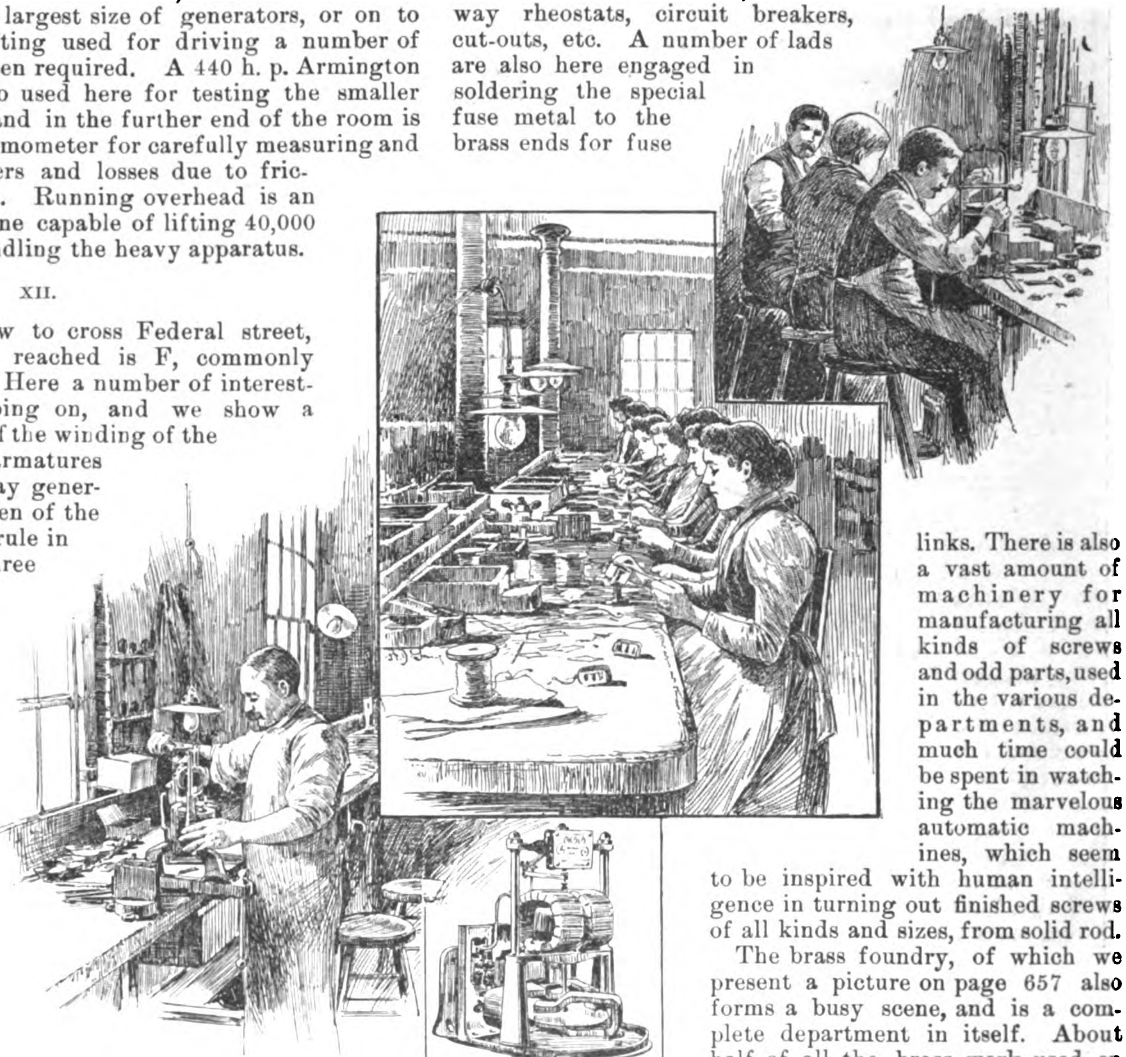
Probably one of the most interesting and attractive portions of the whole factory is the part of factory D, which is devoted entirely to the purposes of a laboratory for Prof. Thomson, into which, however, but few visitors ever gain access. This laboratory is really a genuine workshop in which are employed some half dozen skilled mechanics besides the regular assistants under the Professor's own supervision. Prof. Thomson is a skilled mechanic himself and can show a workman how to make an intricate piece of mechanism, by practically taking hold of any of the tools in the room. The room itself is fitted up with lathes, planing machines, shapers, drill presses, and all necessary tools. In the centre of the room is a switchboard from which can be derived all kinds of currents, direct and alternating and of high and low voltage. Standing round the room are models of various apparatus recently perfected, and numbers of machines and different pieces of appararatus still in the experimental stage. Attached to this room also is a complete supply department containing sheet metal of all kinds, screws, brass tubing, rods, etc., from which nearly any kind of electrical device can be made. The laboratory can be conveniently reached by a bridge from the office building and the Professor divides his time pretty equally between this room and his own private office.

XI.

Factory K, commonly called the power house is a particularly interesting one, and is devoted to the assembling a and testing of the large railway generators, and we present picture of this room, on page 655, showing an M. P. 500-volt railway generator for the West End Street Railway Company, of Boston, in the process of being tested. Ample steam capacity is provided by two Abendroth & Root boilers and four Manning boilers situated in an adjoining room, the

Fitting Thomson Wattmeters.

steam pipe connections to the engines being all carefully covered with magnesia sectional covering to prevent loss from radiation of heat. The motive power is provided by a large 750 h. p. compound Green engine, in a separate room, with the shaft extending into the power house, on which is hung a heavy driving wheel 18 feet in diameter with 67-inch face. This driving wheel has a double crown and carries two belts, so that it can drive direct onto one of the largest size of generators, or on to a line of countershafting used for driving a number of smaller generators when required. A 440 h. p. Armington & Sims engine is also used here for testing the smaller sizes of generators, and in the further end of the room is provided a large dynamometer for carefully measuring and testing the horse powers and losses due to friction and other causes. Running overhead is an electric traveling crane capable of lifting 40,000 pounds, for use in handling the heavy apparatus.



Building the Thomson Recording Wattmeter.

XII.

The visitor has now to cross Federal street, and the first factory reached is F, commonly called the car shop. Here a number of interesting processes are going on, and we show a glimpse on page 656 of the winding of the heavy Gramme ring armatures for the monster railway generators. Some half dozen of the heaviest size are as a rule in process of winding, three men being necessary for each armature, one skillful armature winder and two assistants. In another part of this shop are situated a number of heavy punch presses, shown on page 656 stamping out the laminated armature cores from the thin metal sheet. Another series of machines are busy punching out the slots in the outside circumference of these armature cores, which are destined later for the reception of the winding. The pieces for the railway rheostats are also punched in this shop, and a number of presses are also kept busy punching out large quantities of mica for various purposes. Alongside is the factory F extension which contains the forging shop, where all the smaller forgings used in the manufacture of the various classes of Thomson-Houston apparatus, are made in the usual way by the aid of a large number of steam hammers and brawny sinewed smiths. We show two views of this shop on page 657 and it will be observed that the Thomson electric welding apparatus is used extensively in this department. Passing into factory H, we come upon a busy scene, some 75 men being kept constantly employed in shipping the entire product of the various factories. In order to give some idea of the magnitude of this work it is interesting to note that during last year, 1891, no fewer than 40,000,000 pounds passed through this department, and were safely loaded on the freight cars on the adjoining tracks. Every convenience for handling this work has been provided, the railway tracks being alongside one end of the building, the tramway track which communicates with every department of the factory, running into this room, while overhead cranes, used for lifting the heavy pieces into the boxes and conveying them from one part of the room to another, are called in constant requisition. Two large stock-rooms are also situated at one end of this room, while on the floor below all the old scrap is carefully sorted out, and the different metals are assigned to different heaps for future use. The third floor of factory H is devoted to the manufacture of all kinds of small articles, such as railway rheostats, circuit breakers, cut-outs, etc. A number of lads are also here engaged in soldering the special fuse metal to the brass ends for fuse links. There is also a vast amount of machinery for manufacturing all kinds of screws and odd parts, used in the various departments, and much time could be spent in watching the marvelous automatic machines, which seem to be inspired with human intelligence in turning out finished screws of all kinds and sizes, from solid rod.

The brass foundry, of which we present a picture on page 657 also forms a busy scene, and is a complete department in itself. About half of all the brass work used on commutators, armature spiders, lamp coils, spools, brackets, etc., is here cast, a large gang of men being kept in constant employ, the remainder of the brass castings being purchased from outside foundries.

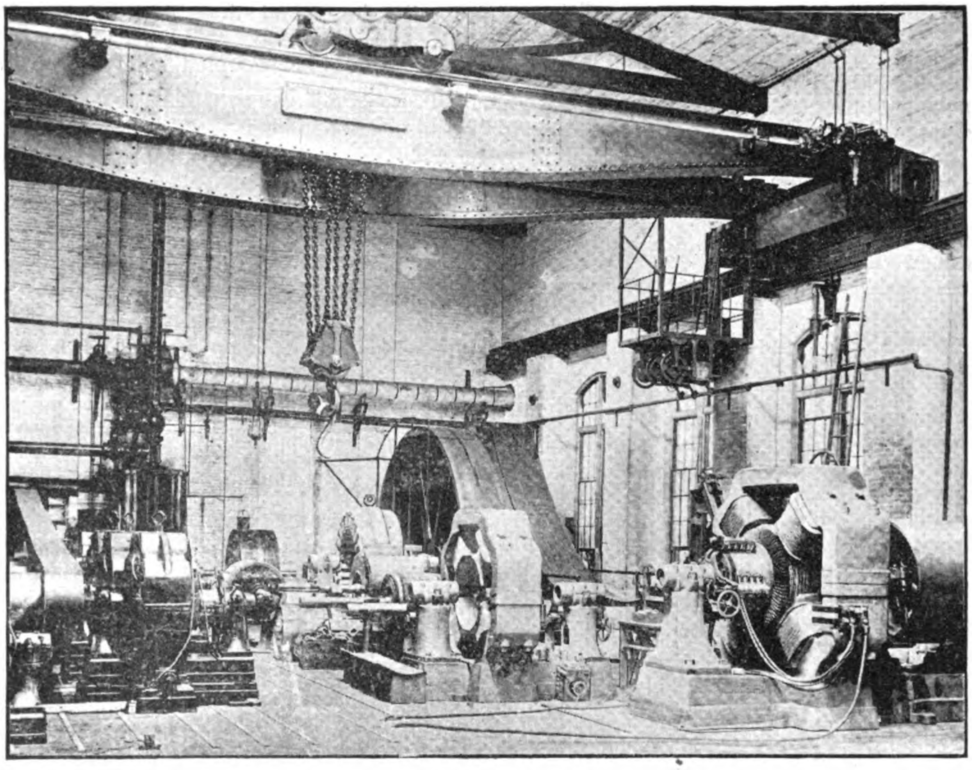
XIII.

The lighting and power circuits of such a large factory are a matter of considerable importance, and the question becomes even more involved when it is desired to use the dynamos or generators which are being tested from day to day on the shop circuits. At present there are about 300 arc lights and 3,000 incandescent lamps in daily use for lighting in the shops, and the dynamos for running them are distributed in various locations. The switchboards are interlaced in such a fashion that the load can instantly be transferred from the regular dynamos to any generator or dynamo under test. Such a combination is extremely valuable not only for testing purposes, but in the case of shutting down at night of any engine the factories can always be lit up from some other engine. Besides the lighting plant there are in use for power purposes, four 100 h. p. and one 80 h. p. generators, with about 500 h. p. of motors distributed through the shops, doing all kinds of work, such as driving shafting, elevators, cranes, electric motor cars, locomotives, etc. The system of switches is the same as for the lighting plant, so that any generator being tested can be used for this purpose.

The company are now erecting on the bank of the Saugus river, a power house, 120 feet x 250 feet, which will contain the entire electric and steam plant except that for heating the factory. As the location is about a mile from the present buildings it will be a good example of the electric transmission of power for factory use.

XV.

The rapid growth of the factory at Lynn, and the immense amount of detail work, necessarily requires a large force of clerks, draughtsmen, engineers, stenographers and other assistants, and about two years ago the handsome building known as Office Building in the plan was erected for office purposes. This building is situated on Center street, between the factories C and D, and is of convenient access from all parts of the factory. It measures 125 feet deep by 48 feet wide, and is four stories high. On entering the office building, one enters first a small reception-room, guarded by a military-looking gentleman, who requests the visitor to write his name in a large register, and will then courteously take care of his magnetizable watch while he is being shown through the factory. Behind this reception-office is situated the office of the production department, of which Mr. D. M. Barton is manager, who, with his corps of clerks, sees that the proper production of apparatus is kept up, and that a sufficient supply of new material is ordered and received.

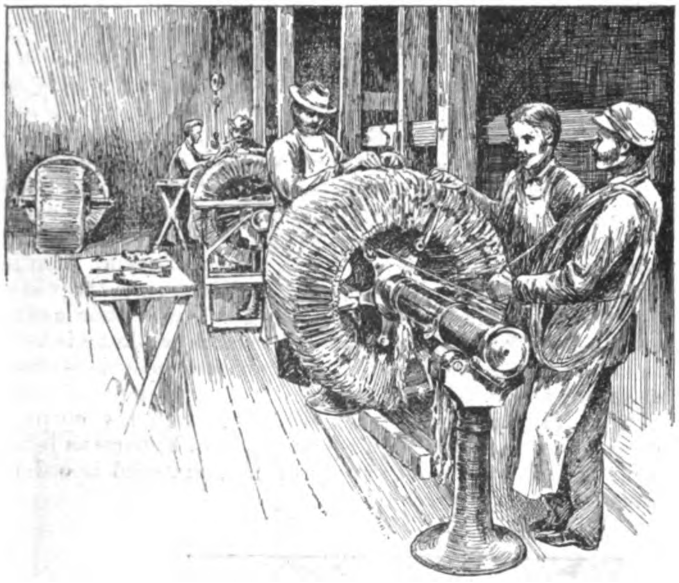


THE POWER HOUSE, FACTORY "K," SHOWING AN M. P. 500 RAILWAY GENERATOR UNDER TEST.

XIV.

A description of the factories would be incomplete without a short reference to the electric motor and tramway service which connects all parts of the different factories. There are three of these electric cars used, and they are equipped with some of the first motors here made, and have seen years of service. They are used for hauling parts of machines from one shop to the other, and can pull a trailer with several tons load up a 12 per cent. grade and around very sharp curves. Besides these there is in use in the freight yard an electric locomotive for handling the freight cars. It consists of a heavy truck equipped with two double-reduction 20 h. p. motors. It is capable of pulling a heavily loaded freight car around sharp curves and on a three per cent. grade, at the rate of about four miles an hour. The Thomson-Houston Company do all their own shifting of cars, and handle some 12 or 15 loaded cars a day, hauling them some 300 or 400 feet from the factory down to a spur track of the Boston and Maine railroad.

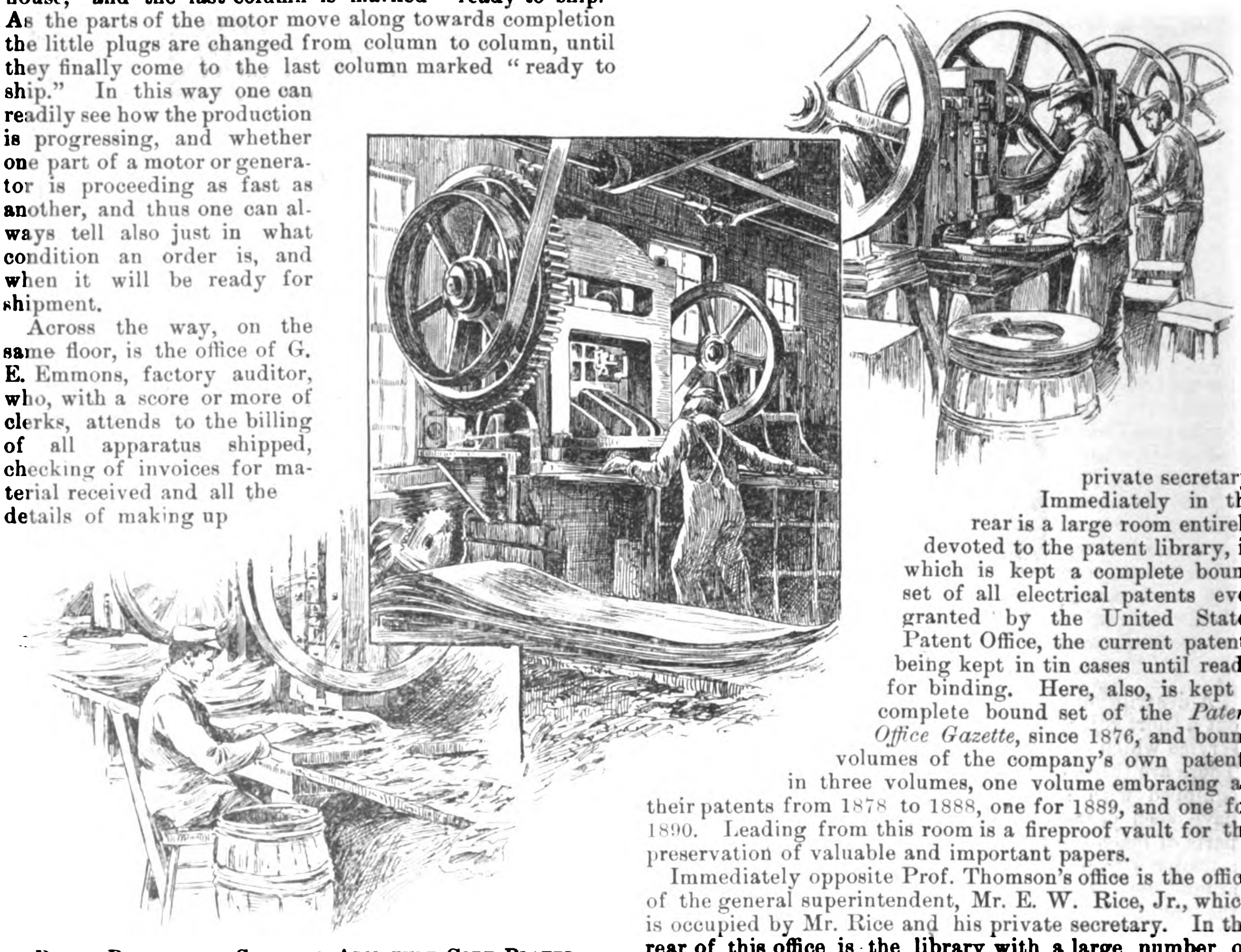
This office is fitted up with a number of boards, which are arranged as shown in the picture on page 660. They indicate to the eye the condition of every generator and motor and their principal component parts in process of manufacture. One board is provided for each of the different types built as follows: Arc dynamos, spherical type incandescent dynamos, alternating dynamos, stationary motors, motor or "D" type dynamos, railway motors, multipolar generators, special generators and motors, and all generators and motors for shop use. Each of these boards is subdivided into columns, each column having a number of small holes into which are inserted little plugs bearing the number of the part, and representing some special piece of apparatus, such as an armature, or a field or core, or, in some cases, a complete dynamo, motor or generator. Taking the railway board, for example, it is divided into columns as follows: At the left hand is a column showing the motors ordered, the class and the destination. At the right hand is a column for "fields set up," then one for "shafts inspected," another for "cores (shaft and core)" another for "winding," another for "wound," another for



Winding Large Railway Generator Armatures.

"connected," another for "baked," another for "in car house," and the last column is marked "ready to ship." As the parts of the motor move along towards completion the little plugs are changed from column to column, until they finally come to the last column marked "ready to ship." In this way one can readily see how the production is progressing, and whether one part of a motor or generator is proceeding as fast as another, and thus one can always tell also just in what condition an order is, and when it will be ready for shipment.

Across the way, on the same floor, is the office of G. E. Emmons, factory auditor, who, with a score or more of clerks, attends to the billing of all apparatus shipped, checking of invoices for material received and all the details of making up the weekly pay roll, which amounts to between forty and fifty thousand dollars.



Punch Presses for Stamping Armature Core Plates.

The basement of the office building is devoted to testing purposes, and is full of valuable apparatus. Here is situated the instrument-room for calibrating voltmeters, ammeters and various instruments for their own use in the factories. It is equipped with the highest class of instruments for accurate calibration by various methods, including a very fine Thomson quadrant electrometer, various high reading galvanometers, dynamometers, resistance boxes and all the other necessary apparatus required for delicate work.

In another part of this basement are situated a number of huge cabinets for the reception of the thousands of drawings which have been used in past years. A little further on there is a special switchboard by which any kind of current can be obtained for magnetic and other tests. Another part of the room is devoted to machines for testing tensile and compression strains of metals, and special machines for testing the torsion strains of wires and metals.

This department also contains a complete chemical laboratory for analytical work, and the company has found it to be a very valuable adjunct, as it is better able to keep up the standard of raw material which is used.

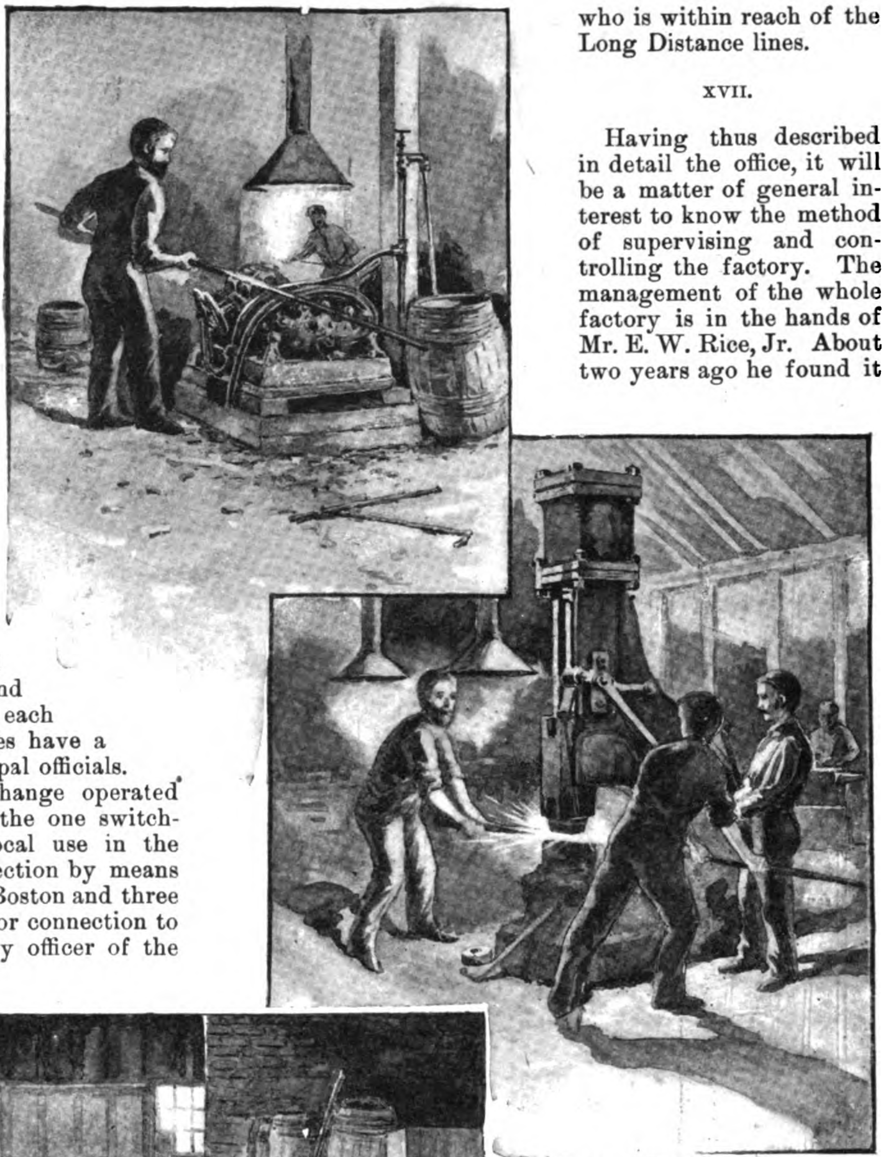
XVI.

On the second floor, occupying a front corner, is Prof. Thomson's private office, which is a bright, cheerful room, and which is occupied solely by Prof. Thomson and his private secretary. Immediately in the rear is a large room entirely devoted to the patent library, in which is kept a complete bound set of all electrical patents ever granted by the United States Patent Office, the current patents being kept in tin cases until ready for binding. Here, also, is kept a complete bound set of the *Patent Office Gazette*, since 1876, and bound volumes of the company's own patents in three volumes, one volume embracing all their patents from 1878 to 1888, one for 1889, and one for 1890. Leading from this room is a fireproof vault for the preservation of valuable and important papers.

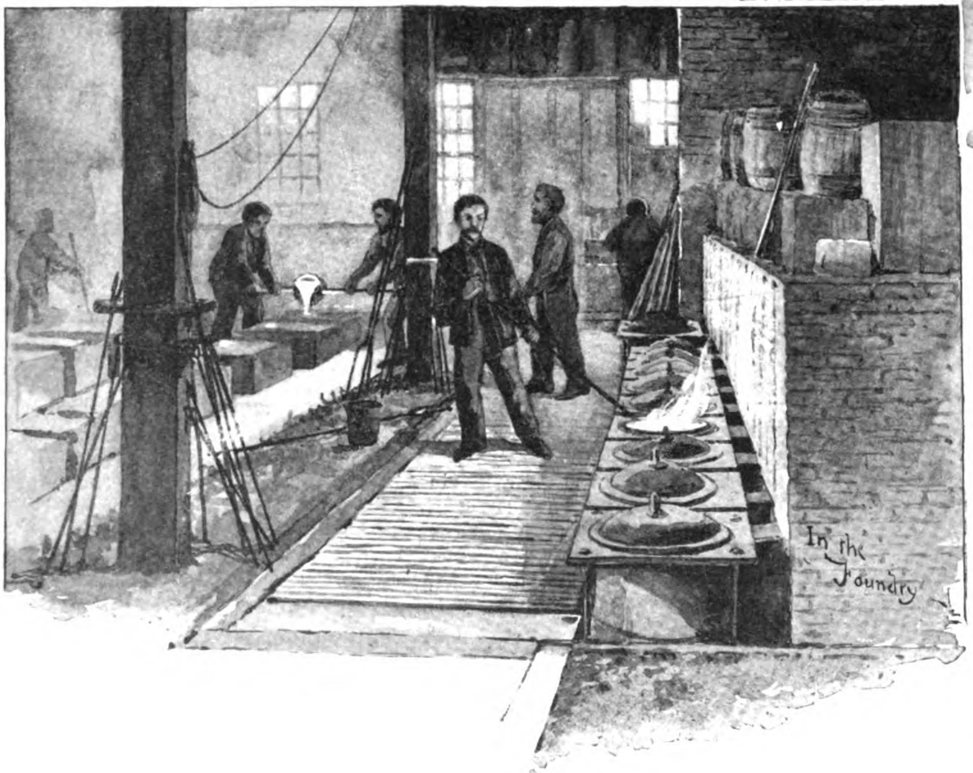
Immediately opposite Prof. Thomson's office is the office of the general superintendent, Mr. E. W. Rice, Jr., which is occupied by Mr. Rice and his private secretary. In the rear of this office is the library with a large number of books of reference and complete sets of bound volumes of the principal electrical and engineering periodicals. Adjoining the library is the office occupied by Mr. Rohrer and Mr. Knight. In the rear of the building, on this same floor, is Mr. Baker's office, who, with his assistants, looks after the mechanical details. The remaining portion of this floor is devoted to the requirements of the electrical and engineering corps, large and comfortable rooms being occupied by both departments.

The third floor is entirely devoted to the drafting-room, which is perhaps the largest and best-equipped of the kind in the country, and of which we present a picture on page 661. At present there are employed in this room alone 97 draughtsmen, engaged in designing the various devices which are manufactured in the factories. The arrangement of the drawings for ready reference is very complete. The card-catalogue system is used, and all drawings are indexed by titles and numbers both, so that any one of the 6,500 or more drawings can be referred to without any loss of time. On the roof of the building is a large and well-appointed house for the making of "blue prints," such as are well known to every engineering company; a number of men and boys are kept constantly employed at this work alone.

Each office in the building just described is equipped with one or more telephones, and there is also a telephone in the office of each foreman in the factory. These telephones have a desk attachment in the offices of the principal officials. There is also a complete telephone exchange operated by one girl, containing two switchboards, the one switchboard containing 71 drops being for local use in the office and factories, and the other for connection by means of two private lines to the head offices in Boston and three lines to the Lynn central telephone office for connection to the Long-Distance lines. In this way any officer of the company can put himself in immediate connection with any department of the factory, or can talk with any one in the Boston or New York offices, or, in fact, with any one who is within reach of the Long Distance lines.



In the Forging Shop.



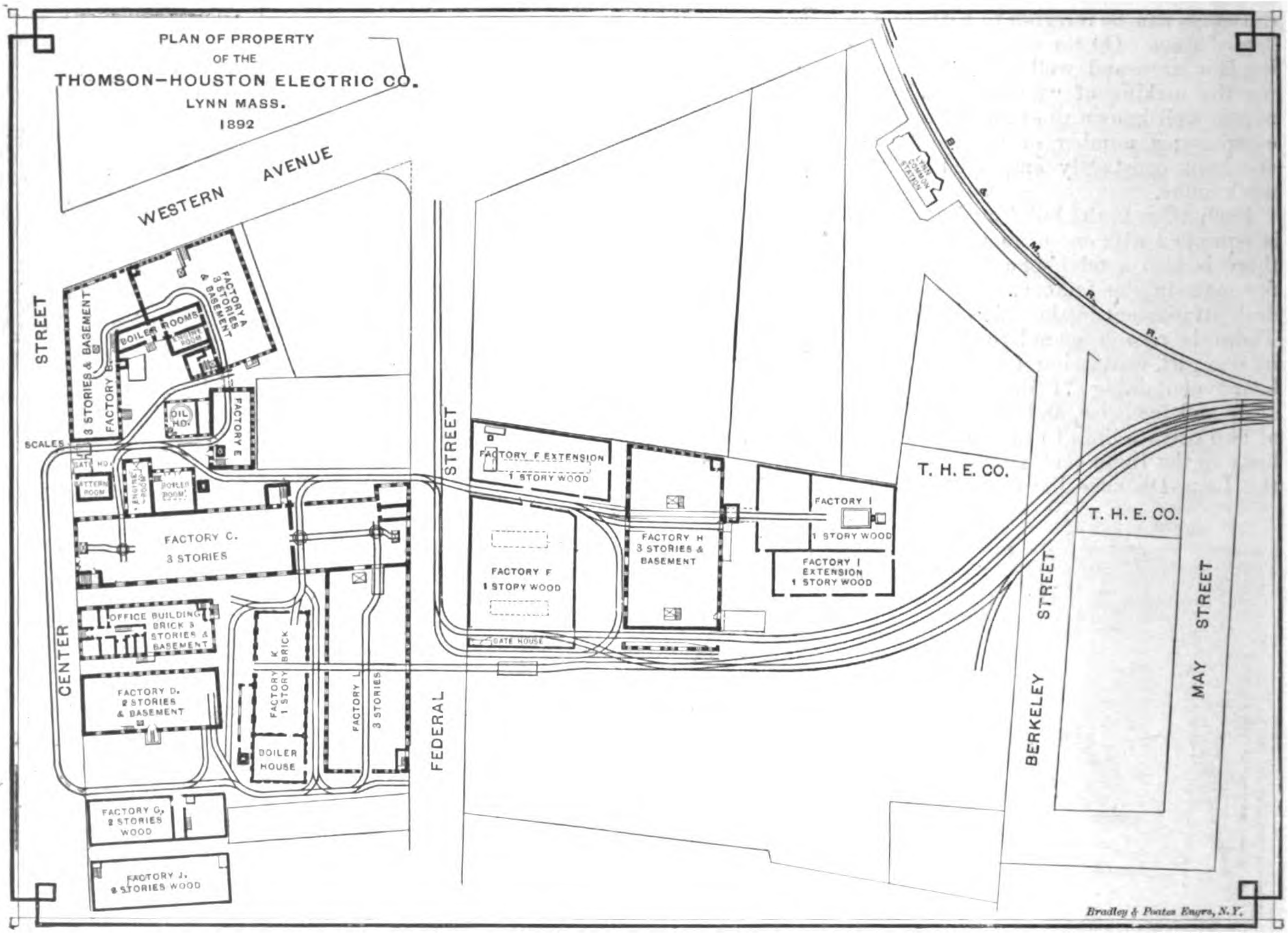
A Corner in the Brass Foundry.

XVII.

Having thus described in detail the office, it will be a matter of general interest to know the method of supervising and controlling the factory. The management of the whole factory is in the hands of Mr. E. W. Rice, Jr. About two years ago he found it desirable to adopt some means of relieving himself of a large part of the routine work in order to allow him more time to devote to the technical and engineering part of the work which is more to his taste. Accordingly the "factory committee" was organized, its purpose being to assist Mr. Rice in the general supervision of the factory and as a governing power in his absence. The committee of whom we present portraits on page 659 consists of Mr. Rice, Mr. D. M. Barton, production manager; Mr. I. F. Baker, mechanical superintendent, and Mr. G. E. Emmons, factory auditor. They hold weekly meetings, or oftener if necessary, and they deal with all problems relating to factory employees, and facilities of manufacture, and exercise a general control over the foremen.

All acknowledge that the applications of electricity have had a remarkable development in the last three years, but it is not clear to all that this has crowded the factory work in order to meet the growing and increasing demands, both in the designing of new apparatus and in the manufacture of the same. The Thomson-Houston Co. has systemized its engineering force in such a way that it has been able to meet these demands in a very satisfactory way by subdividing the work into different departments, with an experienced engineer, specially skilled in that branch, at its head. The chief of these is the railway department with Mr. W. H. Knight, as chief engineer, who devotes all his time to railway work and has an efficient corps of engineers under him to whom he delegates parts of the work.

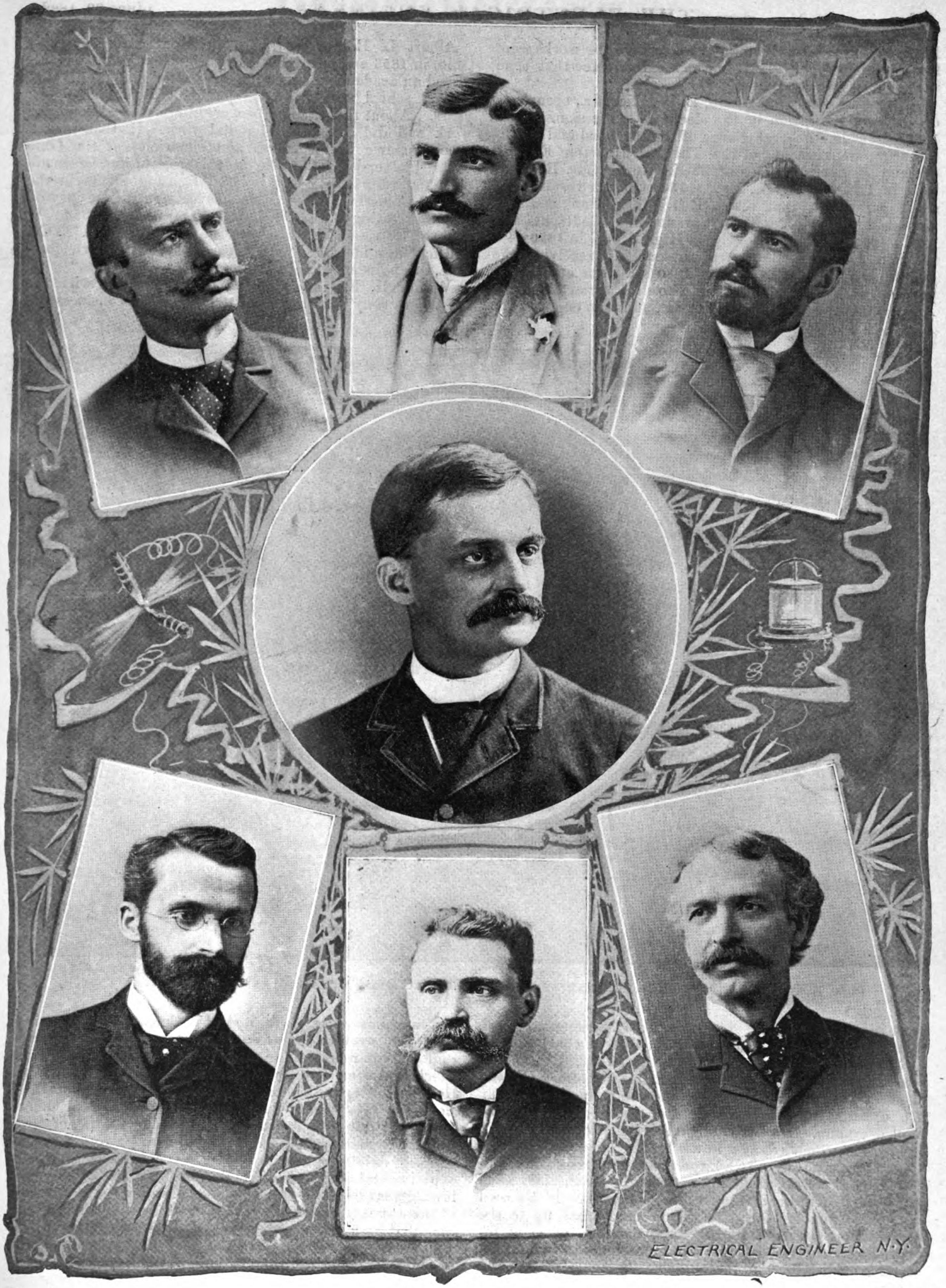
The other chief engineers are as follows: Mr. F. O. Blackwell, mining apparatus; Mr. J. P. B. Fiske, stationary motors; Mr. Axel Ekstrom, alternating apparatus, and Mr. H. G. Reist, multipolar generators. It should be stated here also that Prof. Thomson is also called upon when any very important question arises, and Mr. Rice exercises a judicial supervision of all the departments, being ably assisted in this by Mr. A. L. Rohrer. These departments have been organized for the purpose of bringing any apparatus carefully through its experimental stage, to a state of perfection, after which they are required to keep a careful watch on the production to keep it up to the high standard of excellence, all questions regarding the working of the apparatus or complaints being referred to them for reply. In addition to the gentlemen named above, there are a number of other engineers who are able intelligently to take up any problem which may arise, who form a complete corps of electrical and mechanical engineers capable of developing any of the electrical engineering problems of the day.



Plan Showing Location and Arrangement of the Thomson-Houston Factories, Lynn, Mass.

XVIII.

A word or two by way of biography may not be out of place as to the men just mentioned as constituting the executive of the factory. First and foremost, of course, comes Prof. Elihu Thomson himself. He was born in Manchester, England, in 1853, of Scotch and English parentage. At the age of five Elihu Thomson went with his parents to Philadelphia, U. S. A., where they settled. He was educated in the public schools of Philadelphia, and graduated at the Central High School in 1870. After graduation, at seventeen, he spent six months as analyst in a laboratory in Philadelphia, and first lectured in public about this time. He was then appointed Assistant Professor of Chemistry and Physics in the Central High School in the fall of 1870, having charge of the chemical laboratory. This position he filled until promoted to the chair of Professor of Chemistry and Mechanics in the same institution in 1876. He lectured frequently on scientific topics, and had charge of the Department of Chemistry in the Artisan's Night School of Philadelphia. He was appointed lecturer on electricity at the Franklin Institute in 1877 and worked on its committees, notably the committee on dynamo-electric machines, the report of which was published in 1878. He had been at work on dynamo machines and electric lighting from 1874, and later associated with himself in such work Prof. Edwin J. Houston. Several joint patents were taken out with Prof. Houston, notably the three-coil armature and regulation of current by the shifting of the commutator brushes. Upon these and other inventions the American Electric Company, now the Thomson-Houston Electric Company, was organized in 1880, and Prof. Thomson became its electrician, resigned his professorship at the Central High School, and removed from


ELECTRICAL ENGINEER N.Y.

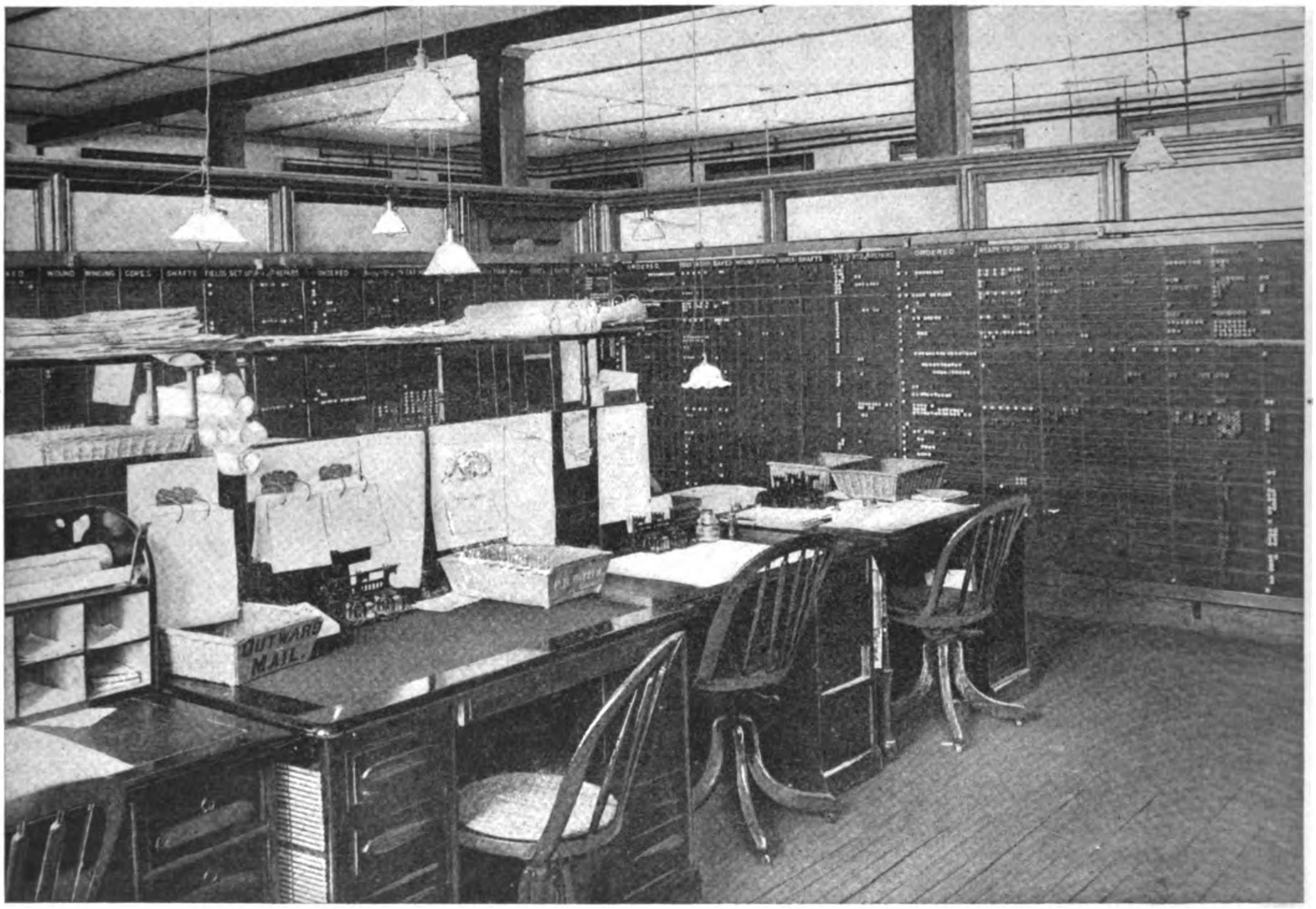
A. L. Rohrer.
W. H. Knight.
E. W. Rice, Jr.

Prof. ELIHU THOMSON.

G. E. Emmons.
I. F. Baker.
D. M. Barton.

Philadelphia to New Britain, Conn., where the works were first established. Prof. Thomson's career since that time is known to everybody.

Although a very young man, E. W. Rice, Jr., occupies a distinguished position in the electrical profession. Since 1885 he has had general charge of the technical and manufacturing departments of the Thomson-Houston Electric Co. and besides has been a prolific inventor. Mr. Rice was born in La Crosse, Wis., May 6, 1862. After residing for short periods at that place, Red Wing, Minn., and Milwaukee, he removed, with his parents, to Philadelphia and graduated from the Philadelphia High School in 1880 with the degree of Bachelor of Arts, subsequently receiving the degree of Master of Arts. In 1880 Mr. Rice accepted a position with Prof. Thomson, who had formed the old American Co. at New Britain, Conn., and was engaged for some time in building instruments, experimenting and doing general work. Under Prof. Thomson's instructions he made the drawings, wound the armature, did the assembling and testing and supervised the machine work for the first machine constructed by the company—a one-light arc dynamo. The company's first plants were also installed by him. During that period Mr. Rice made many inventions which are now in use by the Thomson-Houston Company, in addition to a large number of designs and improvements, which, while not necessarily patentable, have yet been of practical value to the company. In his own name, and jointly with Prof. Thomson, he has up to the present time been granted about 50 patents, covering inventions on arc lamps and dynamos, methods of regulation, systems of distribution, incandescent dynamos, meters and general details, and he now has a large number of applications in the Patent Office.



Plug Boards in the "Production Department" Showing the Condition of the Work in Every Department.

Albert L. Rohrer was born in Montgomery county, Ohio, in 1856 and spent his early life on a farm. He received an academical education and after graduating at a normal school taught in the public schools for several years. About this time he became interested in telephonic work and did some experimental work. He then took a special course in mechanics and electricity at the Ohio State University and while at this institution he made efficiency tests on several isolated lighting plants in the city of Columbus, Ohio. He was assistant to the jury on electric lighting at the Cincinnati Exposition of 1883. In June of 1884 he became connected with the T.-H. E. Co. and has been identified with them either as expert, foreman, or engineer ever since.

Walter H. Knight, who has been identified with the electric railway industry since 1883, began his business life as a machinist at Lane & Bodley's, Cincinnati, Ohio. He then spent over six months at the Centennial Exhibition in Philadelphia reporting on machine exhibits, and then took a technical course at McMicken University in Cincinnati. He was afterwards employed as an examiner in the electrical department of the United States Patent Office, from which he resigned in 1883 to engage in the electric railway business as engineer for the Bentley-Knight Company. While working for this company he installed an experimental road at Cleveland, Ohio, and during the following year he exploited the first electric street railway in this country on the East Cleveland line. This line was operated by a conduit in connection with an overhead line, and the motors were at first run in series but afterwards in multiple, being the first instance of both methods, as it was the first road operating a plurality of motors.

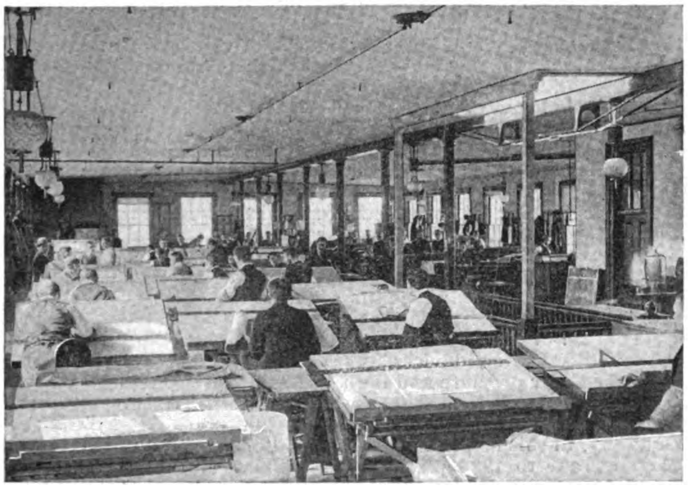
Mr. Knight's next experience was at the Rhode Island

Locomotive Works, where he constructed an experimental road at Woonsocket, R. I., and then a combined trolley and conduit road at Allegheny, Pa. Both of these roads were operated by Thomson-Houston motors and dynamos.

Determined to pursue the conduit system to a definite conclusion, a still larger installment was put in on the West End Road, in Boston, but the difficulties encountered with the severe climate and the poor quality of American street pavements rendered the service too unreliable to justify further experimentation.

The subsequent efforts of Mr. Knight were directed wholly to the overhead system. In 1889 Mr. Knight was called to London to testify before the Parliamentary Committee on the feasibility of operating underground trains by electricity, and he submitted plans showing electric locomotives with gearless motors. Upon his return to this country, the Thomson-Houston Electric Company having obtained a controlling interest in the Bentley-Knight Company, Mr. Knight entered the services of the former company, and after some time spent in the Patent Department in Boston, was placed in charge of the Railway Engineering Department at Lynn, a position which he still occupies.

Daniel M. Barton was born in Ware, Mass., in 1843. He received a common school education and was apprenticed to learn the trade of boot-maker. When only nineteen years old he enlisted for the war in the Tenth Massachusetts Regiment, and after several years' service returned home and was employed for a number of years in various mercantile firms. Part of the time he was with his brother Mr. S. A. Barton, one of the founders of the Thomson-Houston Co., in the newspaper and periodical business in Lynn, Mass. In February, 1886, he was employed by the Thomson-Houston Electric Company as a clerk and has been with them ever since. During the last three years he has been production manager at the works.



THE DRAUGHTING ROOM.

George E. Emmons was born in Westchester, Ct., in 1857. He received a common school education and at the age of fifteen began serving a six years' apprenticeship in a country general store. After this he was employed for one year by T. R. Pickering & Co., Portland, Ct., and then accepted the position as book-keeper for the American Electric Company, at New Britain, Ct. After the controling amount of stock was purchased by the Brush Company representatives, he entered the service of the firm of the North & Judd Manufacturing Co., saddlery hardware manufacturers at New Britain, Ct., and was principal book-keeper and confidential clerk for this firm until 1886, when he resigned to accept a position with the Thomson-Houston Electric Company, at Lynn, Mass., with whom he has remained ever since.

I. F. Baker, the mechanical superintendent of the factory, was born at Birmingham, England. He was at school until he reached twelve years of age, and soon after he began to learn the trade of gunsmith. He completed his technical education in the night classes at the Birmingham Midland Institute and the School of Arts. Upon coming to this country, he worked for Pratt & Whitney, the Whitney Arms Co., and the Winchester Repeating Arms Co. In 1880, he became associated with the United States Electric Co., and then entered the service of the Thomson-Houston Electric Co., in 1886.

COMING DEVELOPMENT OF ELECTRIC RAILWAYS.—III.

BY FRANK J. SPRAGUE.

Every system has its limitation. The electric is not exempt from this law, and hence I will set forth what are well-known limiting laws concerning the transmission of energy. They have been stated time and again, but people often lose sight of them in discussing the question of investments in large electric railways, so that I think it would be well perhaps to restate and emphasize them.

The weight of copper necessary to transmit a given amount of power with a fixed loss will vary inversely as the square of the electromotive force used.

The distance to which it can be transmitted with a given weight of conductor will vary directly as the pressure.

The distance to which it can be transmitted over a conductor with a given cross-section will vary directly as the pressure.

The weight of copper necessary where the supply station is in the centre of a system is only one-quarter that required if the station is at one end.

The weight of copper will vary inversely as the square of the number of supplying stations properly placed.

The electromotive force required will vary inversely as the number of stations.

Lack of knowledge of these simple and inalterable laws has led to much misconception of electrical possibilities, and these have not been confined to electrical engineers. In many of the suggestions which have been made, even by practical steam engineers, there has been an unnecessary confusion of the inpracticable and the practicable, and the specific object which should have been borne in mind has been lost sight of. Committees have drawn impossible specifications for trunk line service, and demanded of electric motors a capacity and performance superior to that of the best compound steam locomotives. I unhesitatingly pronounce any attempt to build such machines, for the present, certainly unnecessary and impracticable. The service thus suggested, if at all needed, will for many years be better performed by the steam locomotive than the electric.

Leaving out of present consideration trunk line work, there are three problems requiring solution in the application of electricity to propulsion on a large scale under conditions existing, for example, in Chicago or any other place where there is a movement of a large number of trains on more or less complicated tracks as will be found at almost all terminal railway stations. They are: First: The development of an electric locomotive of ample power which shall be as readily controlled as the steam locomotive, shall be reliable in operation, and shall show a higher economy. Of course such a machine must have all the adjuncts which are necessary for train movement.

Second: A system of conductors and methods of supporting the same which can be relied upon for ample supply of current and absolute certainty of continuous contact at all speeds on curved switches, cross-overs and the multitudinous combinations which exist on yard tracks.

Third: A system of automatic block signaling, which, while effective for steam traffic, will not be thrown out of operation by the use of tracks as conductors of electricity for a general supply. This is a more serious question than would at first appear, for this use will materially interfere with, if not absolutely destroy, the utility of what is known as the rail circuit system. This third problem is one which must necessarily follow the development of the other two, as the automatic signaling systems now existing have followed the development of steam practice. While I am not by any means thoroughly familiar with the various methods of automatic signaling, I believe I am justified in saying that there is none at present existing which will meet all the requirements of railway practice, and which can be operated on tracks used by both steam and electric locomotives, where the rail is used as a part of the supply circuit. Some of the best known systems of signaling would be rendered entirely inoperative.

As difficult as it may seem to devise such a system, I believe that it certainly can be developed, but only properly so on a section of track which is more or less experimental, on which, at the time of operation, automatic signaling is unnecessary, but which is actually operated by both classes of service. Such an experimental section would be a combination of single and double tracks with all the varieties of curves, crossings, switches and ladders; such as would be found in any large yard. It will probably be found necessary to erect a variety of kinds of conductors.

From the most careful consideration which I have been able to give to the subject, I believe there is one way, and only one way, in which the current can properly be supplied in any complicated system, and that is, from the overhead conductor, practically rigid in character, following very nearly the centre line of all tracks and switches with no movable overhead parts, and with return through the rail. The locomotive would then practically be moving between two electric planes, the lower being the guiding one.

I know there has been a great deal of talk about other possible systems of supply. We have heard much of the charged rail using low potential currents supplied at frequent intervals by motor-generators driven from a central station. Since we have discovered no conductors devoid of resistance, and the art of welding is not particularly applicable for railway service where moving contacts are a necessity, little credence need be given to any scheme of this character.

We heard again of the central rail supported on posts in wells between the tracks. A centre rail may be acceptable on a system like that of the elevated railroads, but in ordinary railroad work any ditch intended to drain a track so as to keep insulators dry and keep snow away from them would probably so open the track that any moisture and frost would cause upheavals of a serious character, and the cost of maintaining the track would be prohibitory. The use of snow machinery for keeping the track clear would be impossible, and anything underneath the car is in the most exposed place for sustaining damage by defective rolling stock and continually liable to all sorts of mechanical injuries and accidents with all the evil results of interruption of current, short-circuiting and stoppage of traffic.

Another system which has been proposed is that of a conductor supported on posts alongside of the track and elevated but three or four feet above it. While not open to so serious objections in the matter of insulation as a centre rail system, its use, where there are crossings or switches, is manifestly not to be thought of. Even on a straight, clear track in a hard climate there would be most serious trouble in the matter of clearing the tracks from snow and with the grade crossings in this country gaps in the conductors would be too great for the contacts on a single locomotive to stand.

Some time ago I was requested on behalf of a well-known financial man, whose enthusiasm as to the possibilities of electric traction is well known, but who is withal a most practical railroad man, to inspect various railroad terminal tracks in Chicago with a view of, first, the substitution of the switching work now done by a part, or all, of the 1,800 or more switch engines by electric motors, and eventually the operation of suburban service.

You have before you a map showing the railroads, nearly as they exist, on a number of systems in Chicago in the space of about two square miles, or more exactly 1¼ miles in length by ¾ of a mile in breadth; it is no exaggeration to say that there is, or will be, not less than 75 miles of track, and switches and crossings with their various combinations almost innumerable.

I went over and over some of these tracks with the one thought in my mind, How can the current be delivered to the locomotives and how can the automatic signaling be done? And I was forced to the one conclusion, to which it seems every man who makes the investigation must come, and that is, that the overhead system of supply is the only one; but that it must be as substantial and thorough in character as that of any other part of the system; and, further, that, in view of the cost, such a system is only permissible where the number of units operated is large and continuous. These conclusions are not new, but they have been emphasized by the particular problem which is here represented.

Intimately connected with the question of conductors, and one of the most serious ones which has to be met by the electrician, is that of potential. The personal danger limit, with continuous or ordinary frequency alternate currents, is pretty well determined, and it seems generally admitted by constructors that the danger limit for the continuous current machine, with its commutator, is about the same as the personal danger limit. Hence we meet with two dilemmas. If using continuous current motors, we are limited to a difference of potential per machine of 1,000 to 1,200 volts, and we can, so far as safety of the machines is concerned, only probably go above this limit by putting the motors in series, precisely as has been proposed for long distance stationary transmissions. If this is not done, then we have the introduction, between the transmitting dynamo and the receiving motor, of a motor-generator system,- another pet theory which is often suggested but which I unhesitatingly pronounce as so uneconomical as to be impracticable.

If using an alternate current system, then converters must be used, either distributed along the line and supplying the working circuit or placed upon the locomotive to safeguard the motors. While the use of a converter under these conditions is not as objectionable as the use of a motor-generator, it cannot commend itself as a very practicable scheme, and certainly in view of the fact that no single-phase simple alternate motor promises up to the present serious success.

For the present, and I think for a long time to come, we must confine ourselves to the consideration of railroad problems where continuous currents are used, and where the traffic between two points is sufficiently large to justify the investment in central stations and conductors which would be required for the operation of such assistant.

There are two methods of propelling trains electrically, one by following steam practice, that is, by building a large motor and hooking it to the head of a train, the weight of the motor being such as is required for the necessary power and traction when grades or slippery tracks are encountered. From all that has been developed up to the present to get the control that is necessary and to build the machines safely, the electric locomotive will weigh nearly as much per horse power as the steam locomotive. This weight can be better distributed, but I do not think, if steam practice is followed on trunk line service, that there could be any very material reduction of weight of train.

The other plan is to have each car propelled by one or more motors. This would be the ideal system so far as propulsion goes, provided the electric motor was unlike all other mechanical apparatus, in that it never failed, and if a number of machines could be as well taken care of, cost no more, and show as little depreciation as fewer machines of larger capacity operated as a unit.

Should we ever arrive, as we all hope, to the possession of a single-circuit alternate current motor, then, in view of the simplicity of its control, we may fairly hope for the distributed motor system. But here, also, the capacity, and likewise the weight, of the motor, being determined by the total duty done, the weight of train limit would not be decreased but rather increased.

If, on the other hand, single units are used, the query naturally arises, What form would the electric locomotive of the future take? I do not think this is by any means settled; undoubtedly gearless machines will be used, but whether they will be mounted directly upon the axle, or whether they will movably enclose the axle and be flexibly connected to it while their weight is carried on springs on the truck, or whether the motor will be carried on the truck frame and connected to the drivers by the ordinary coupling rods, are questions which will be determined eventually by the depreciation per car mile upon the motors, trucks and road-bed, as well as by the speed to be attained.

Whatever method of mounting the motor is adopted, for reasonable weights and powers, a two-axle truck will be used; but where large powers and weights are necessary, two such trucks will be coupled together so as to keep the weight upon each wheel within limits, and this will carry a cab containg the regulating and collecting devices, and so shaped as to offer the least resistance to air pressure and high speeds.

I have never advocated the use of a connecting rod in transmitting the motion from an armature to a driving axle, but I think it fair to say, in this respect, that the so-called hammering effect on the rails, said to take place in the ordinary locomotive driver where the weights are counter-balanced, exists more in imagination than in fact, and that the chief trouble in the use of the connecting rod is the change of direction of its movement.

Legal Notes.

INCANDESCENT LAMP LITIGATION.

THE UNITED STATES ELECTRIC LIGHTING COMPANY *vs.* THE EDISON LAMP COMPANY.

THE following is an abstract of the opinion of Justice Acheson, of the U. S. Circuit Court for the District of New Jersey, in the above case, which was delivered on June 21, 1892. The court says:

"This suit is brought for the infringement of Letters Patent of the United States, No. 306,980 dated October 21, 1884, granted to Edward Weston, upon an application filed May 27, 1881, for an improvement in the process of manufacturing carbon conductors for incandescent lamps. The nature of the invention is sufficiently indicated by the claim, which is as follows:

> The improvement in the art of making carbon conductors for incandescent lamps, which consists in first forming a carbon core or base, and then building up said core with carbon obtained and deposited upon the same by and during the operation of electrically heating said core, while surrounded by or saturated with a carbonaceous substance, substantially as hereinbefore set forth.

"A number of defences to the suit have been interposed; but it seems to me to be necessary to consider only two of them, namely first, the prior Letters Patent of the United States, No. 211,262 for the same invention, dated January 7, 1879, granted to William E. Sawyer and Albon Man, upon an application filed October 15, 1878; and second, the alleged public use of the invention by Sawyer and Man and those acting under them for more than two years before Weston's application for a patent.

The court then proceeded to give a summary of the testimony of Weston, and the witnesses in his behalf, which is omitted here, but will be found detailed in the opening argument of Mr. Kerr, printed in THE ELECTRICAL ENGINEER of December 16, 1891, (Vol. XII, p. 663). By this evidence it has been sought to prove that the work of Weston in this direction had preceded in date that of Sawyer and Man. After commenting upon this evidence, the court continued:

"To overthrow the prior patent of Sawyer and Man, which had issued so early as January 7, 1879, and was immediately followed by uncommon publicity, the proof of anticipation by Weston should be at least positive, unequivocal and convincing. *Cantrell v. Wallick*, 117 U. S., 689, 695; *Clark Thread Co. v. Willimantic Linen Co.*, 140 U. S., 481, 492. Taking the proofs as a whole, they fail to satisfy me that Weston's alleged invention preceded that of Sawyer and Man.

"But whatever conclusion upon the question of priority may be adopted, at any rate under the proofs, the defence of two years' prior public use of the invention before the application for the patent in suit, rests upon impregnable ground. A public use does not depend upon the number of persons to whom the use is known, and it is enough if a single specimen embodying the invention is publicly used by even one person. *Egbert v. Lippman*, 104 U. S., 333. And a public use of the invention more than two years before the application for a patent, although without the consent of the inventor, invalidates the patent. *Andrews v. Hovey*, 123 U. S., 267, 274; and 124 U. S., 694.

"In March, 1878, when Sawyer and Man made the invention here in controversy, they were engaged in completing an incandescent electric lamp of their devising, which they perfected to their satisfaction and patented in June, 1878. Between March, 1878, and May, 1879, they and their assigns made a large number of these lamps, and continuously used therein, for incandescent electric lighting, at their workshop in the city of New York, carbons prepared by the method described in and covered by their patent of January 7, 1879; and during that period they there exhibited both the actual treatment of the carbons by the patented method and the use thereof in their lamps to large numbers of persons, besides the workmen in their employ. Clearly this use of the invention, as shown by the proofs, was a public and practical use. It is here worthy of remark that the *Scientific American*, in its issue of March 8, 1879, published a clear description of the process of treating carbons as practiced by Sawyer and Man, and as set out in their patent.

"Now it may be that the Sawyer and Man lamp did not prove the success the inventors supposed it to be, and that no perfect incandescent electric lamp was produced until the fall of 1880. But still, the Sawyer and Man lamp was actually operative and had some practical utility. That it was not a commercial success is not here a controlling consideration. *The material fact is that the method invented and patented by Sawyer and Man for the treatment of carbons was put to successful practical use by them in their lamp.*

"I have only to add that it is quite evident from the proofs, that the issue of a patent to Weston was inadvertently made, in disregard of the expressed views of the examiner of interferences and the examiners-in-chief that Weston was precluded from the grant of a patent by reason of the statutory bar of two years' public use disclosed by the evidence in the interference proceedings in the Patent Office.

"For the reasons above given, and without reference to other alleged defences, the bill of complaint must be dismissed.

"Let a decree be drawn dismissing the bill, with costs."

Inventors' Record.

CLASSIFIED DIGEST OF ELECTRICAL PATENTS ISSUED JUNE 14, 1892.

Accumulators:—

Secondary Battery, H. H. Lloyd, 477,182. Filed Feb. 27, 1892.

Employs an acid proof sheet provided with groups of perforations forming a network over the active material.

Alarms and Signals:—

Limiting Stop for Armatures, R. Varley, 476,845. Filed July 27, 1891.

Has for its object to lock the stop for the armatures of electric bells, etc, so that it cannot work loose.

Electric Train Signal, N. B. Cregier, 476,873. Filed Oct. 27, 1890.

Fire-Alarm System, L. G. Rowand, 477,068. Filed Dec. 14, 1891.

A thermostatic fire-alarm system.

Fire-Alarm System, L. G. Rowand, 477,069. Filed Dec. 14, 1891.

Similar to 477,068.

Fire-Alarm System, L. G. Rowand, 477,070. Filed Dec. 14, 1891.

Similar to 477,068.

Annunciator, L. G. Rowand, 477,071. Filed Dec. 14, 1891.

An annunciator for use in connection with fire-alarm systems.

Conductors, Conduits and Insulators:—

Porcelain Insulator, J. Pass and A. P. Seymour, 476,813. Filed March 21, 1892.

Consists of a porcelain shell filled with a porous cement.

Wire Cleat, A. P. Seymour, 476,827. Filed Mar. 21, 1892.

A cleat adapted to securely hold wires of different sizes.

Circuit-Breaking Insulator, A. P. Seymour, 476,828. Filed March 21, 1892.

Consists of an insulating block having grooves at its opposite ends at right angles to one another and extending along the sides to the other ends.

Insulating Tube for Electric Conductors, A. P. Seymour, 476,964. Filed March 5, 1892.

A wiring tube of insulated material held in place by lateral projections at its opposite ends.

Distribution:—

Junction Box, C. R. Arnold, 476,970. Filed March 22, 1892.

Junction box capable of being used either as a three or four way box at pleasure.

Dynamos and Motors:—

Magnetic Inductor for Dynamo-Electric Machinery, L. S. M. Pyke and E. S. Harris, 476,818. Filed Feb. 15, 1892.

Consists of laminæ of soft iron and laminæ of hard metal interspersed one with another for the purpose of strengthening the inductor.

Field Magnet for Dynamo-Electric Machines, L. S. M. Pyke and E. S. Harris, 476,819. Filed Feb. 5, 1892.

Employs a single magnetizable mass surrounding the coil on the inner and outer circumference on the one face, and extending beyond the coil on the other face.

Compensating Alternating Current Dynamo, O. B. Shallenberger, 476,830. Filed Feb. 13, 1889.

Employs a second armature, coils for establishing a field of force therefor, receiving current from the main armature, a magnetic bridge-piece between points of opposite polarity in the core of the main armature and supplemental coils wound upon the bridge-piece.

Dynamos and Motors:—

Current Alternator, H. L. Tyler, 476,843. Filed Oct. 6, 1891.

Has for its object to provide an alternating machine operated independently of current generators but used in conjunction therewith.

Electric Locomotive, T. A. Edison, 476,987. Filed Mar. 2, 1891.

Relates to supporting the motor upon the truck and means for transferring its motion to the axles.

Detachable Commutator, C. H. Gaylord, 477,175. Filed Dec. 17, 1891.

A commutator so constructed as to be readily detachable without disconnecting the wires of the armature.

Lamps and Appurtenances:—

Spark Arrester for Electric Lamps, W. M. Spencer, 476,983. Filed Feb. 5, 1892.

A screen fitting closely about the carbon of an arc lamp.

Incandescent Electric Lamp, T. A. Edison, 476,992. Filed Jan. 24, 1891.

Employs a wire connected to the middle point of the filament, and extending outside of the lamp for connection with an external circuit.

Electric Arc Lamp, T. A. Edison, 476,993. Filed Oct. 1, 1891.

A feeding and controlling mechanism for arc lamp carbons.

Electric Lamp Socket Switch, G. E. Painter, 477,146. Filed Mar. 17, 1891.

Provides means of turning the individual lamps off or on from a distance.

Measurement:—

Electric Meter, T, A. Edison, 476,990. Filed Aug. 25, 1891.

Consists of means for accurately weighing the deposited metal on the plates of electrolytic meters.

Metal-Working:—

Manufacture of Axes, E. Thomson, 476,967. Filed Jan. 22, 1889.

Claim 1 follows:

Consists in shaping the ax head in separate pieces, which are afterward electrically welded together

Electric Welding, C. L. Coffin, 477,101. Filed Nov. 6, 1889.

The method consists in resisting the passage of the current through the material in any other path than that of the proposed weld.

Miscellaneous:—

Electric Converter, G. and A. Pfannkuche, 476,816. Filed May 14, 1887.

Employs a magnetic envelope, consisting of iron particles insulated from one another surrounding the primary and secondary conductors.

Lightning Arrester, A. Wurts, 476,855. Filed Jan. 21, 1892.

Employs two bare conductors, embedded in the earth and interposed between the aerial conductor and the generator.

Pole for Electric Wires, J. Meyer, 476,889. Filed Mar. 17, 1892.

Lightning Arrester, T. A. Edison, 476,988. Filed Aug. 14, 1891.

Employs two sheets of metal foil separated by a sheet of paraffine paper and coiled in a roll.

Pyromagnetic Generator, T. A. Edison, 476,983. Filed June 13, 1887.

Employs a movable heat-directing shield operated by a motor controlled by the current from the pyromagnetic generator, which is thus made self-regulating.

Method of and Apparatus for Separating Ores, T. A. Edison, 476,991. Filed May 21, 1888.

Electric Clock Synchronizer, J. W. Dulaney and Charles F. Dulaney, 477,049. Filed Sept. 4, 1891.

Electric Elevator, J. H. Clark, 477,100. Filed June 5, 1891.

An electric controlling device for hydraulic elevators.

Railways and Appliances:—

Electric Railway, R. W. Barkley, 476,776. Filed Mar. 12, 1892.

Claim 1 follows:

In an electric railway the combination of a diving bell, an electric conductor passing therethrough, a contact-piece, an insulated conductor leading from said piece, and means for moving said piece reciprocatingly into and out of said diving bell.

Electric Railway, C. P. Tatro, 476,935. Filed July 14, 1891.

Employs an insulated conductor enclosed in a pipe and contact plungers arranged at intervals for conveying the current to the motor.

Trolley for Electric Railways, T. A. Edison, 476,985. Filed Nov. 21, 1890.

Claim 1 follows:

A current collector for electric railways having rods or spikes for making contact with the conductor and a spring pressing each rod or spike outward.

Means for Propelling Electric Cars, T. A. Edison, 476,986. Filed March 2, 1891.

A system of link belt gearing for electric cars.

Conductor for Electric Railways, T. A. Edison, 476,989. Filed August 14, 1891.

A conductor supported on pole insulators between the rails of steam or other railways; the poles rising from the bottom of drains.

Switches and Cut-Outs:—

Electric Switch, F. Broadnax, 476,781. Filed Nov. 3, 1890.

A double-pole quick-break switch.

Electric Switch, A. P. Seymour, 476,829. Filed March 21, 1892.

Employs an attached imperforate cover of insulating material serving also as the switch handle and attached to the spindle.

Telephones and Apparatus:—

Electric Switch, W. M. Goodridge, 476,792. Filed Oct. 19, 1888.

A switch adapted for use at telephone exchange stations.

Metallic Circuit House Telephone System, W. M. Goodridge, 476,793. Filed Sept. 30, 1889.

Employs a loop key having a metallic plunger provided with a groove and springs operated thereby.

Telephone Exchange Apparatus, J. A. Seely, 476,826. Filed Nov. 25, 1889.
Provides ready means of sending current over metallic circuits when they are not provided with any ground connection at the subscribers' station.

Telephone and Apparatus :—
Telephone System, B. Marinovitch & G. Szarvady, 476,887. Filed Sept. 5, 1889.
A "nickle-in-the-slot" arrangement for telephone apparatus.

A FAREWELL BANQUET TO MR. SAMUEL INSULL.

At Delmonico's this city, on Friday, June 24, a farewell banquet was given to Mr. Samuel Insull by a number of his friends on the occasion of his leaving New York to take up the duties of president of the Chicago Edison Co. Subjoined is a list of those subscribing to the banquet:

Thomas A. Edison, O. T. Crosby, C. A. Spofford, J. H. Herrick, J. C. Henderson, R. R. Bowker, John Kruesi, John Muir, T. C. Martin, S. B. Eaton, J. C. Reiff, A. Arango, John S. Wise, C. D. Shain, C. H. Coster, W. P. Hix, F. A. Stevenson, E. H. Johnson, H. Ward Leonard, C. T. Hughes, E. H. Lewis, C. L. Edgar, Thomas Butler, F. S. Hastings, W. E. Gilmore, Henry Villard, S. D. Greene, W. S. Perry, A. Marcus, J. P. Ord, G. W. Davenport, Carl Schurz, A. S. Beves, G. M. Phelps, F. R. Upton, Chas. Batchelor, C. A. Coffin, J. B. Skehan, A. E. Kennelly, Eugene Griffin, E. W. Little, J. F. Kelly, F. P. Fish, Chas. R. Lloyd, J. Hutchinson, F. Z. Maguire, R. T. McDonald, Geo. H. Roe, E. Clark, H. L. Brewster.

Nearly all the above were present. Major Sherburne Eaton officiated most gracefully as toastmaster, and speeches of unusual wit and felicity were made by Messrs J. S. Wise, S. Insull, C. A. Coffin, Eugene Griffin, John I. Beggs, E. H. Johnson, C. L. Edgar, E. Lewis, J. P. Ord. During the evening a solid silver punch bowl was presented to Mr. Insull. The occasion was interesting for many reasons, and emphasized the fact that Mr. Insull's eleven years of close association with Mr. Edison had covered a tremendous and unparalleled industrial development in the electrical field. Although very much averse to banquets and oratory—even of the best—Mr. Edison was present to do honor to one who had served him so long, so loyally and so brilliantly. Altogether the dinner was a great success, and the smoothness with which all the arrangements were carried out was due to the executive ability of Messrs. Dana Greene and Skehan.

Mr. Insull leaves New York for Chicago on June 29, and will at once enter upon his new work.

TRADE NOTES AND NOVELTIES

AND MECHANICAL DEPARTMENT.

The customer is the greatest factor in trade. You can reach him by advertising.

THE VAN NUIS "FULMEN" ARRESTER.

In the development of the Fulmen arrester, illustrated in the cut, Fig. 1, the well-trodden path in the line of indestructible designs was ignored, but the principle of a simple pair of dischargers tenaciously adhered to; because it is believed that no better path can be offered to a lightning discharge from a working circuit, than through a minimum of air gap separating a pair of dischargers connected directly to line and earth, without the interposition of magnets or mechanical contrivance. In other words, the ideal lightning arrester would be a direct connection to earth, and the nearer we approach this ideal of simplicity and effectiveness, the more likley are we to divert the atmospheric discharge into the desired channel.

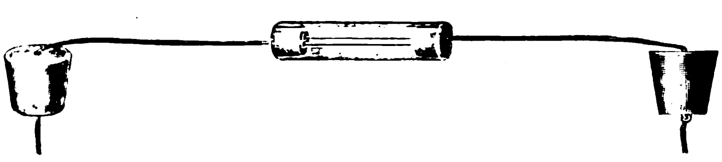


Fig. 1.—"Fulmen" Arrester.

The experience of four years of electric street railway practice, has shown that the chief difficulty in obtaining a satisfactory lightning arrester for power circuits of 500 volts potential, using a ground return, is that the dischargers are frequently destroyed by the arc which follows the lightning discharge, and this not only necessitates a new arrester but leaves that particular locality unprotected, until the new apparatus is put into position.

By utilizing the destructive agent, (the consuming arc) the Fulmen arrester is operated by the very force that continually menaces the would-be indestructible arrester.

The construction of the Fulmen arrester is simply a pair of fine brass wires, two and three-quarters inches long, made to lap each other three-quarters of an inch, with one-twentieth of an inch air gap between them. These wires form the dischargers and are held in position by a high resistance wax. A small glass tube is sealed over the dischargers, to keep them clean and dry, so that the exposed wires of the arrester, between which there is the potential of the circuit, are separated by seven-eighths of an inch of high resistance material.

The soft rubber plugs, at either end of the fuse arrester, serve to hold it in a porcelain piece, and, as shown in the cut, Fig. 2, ten fuses are attached to one corrugated cover, allowing the free ends of the fuses to project through and approach the carbon rods, forming the line and ground terminals, and located in grooves in the porcelain back.

Loose pieces of carbon, made like small wedges, connect the free ends of the upper fuse to the carbon terminals.

In this position the arrester is ready to be placed in circuit.

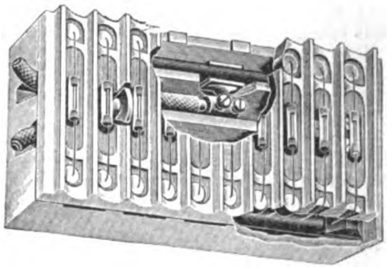


Fig. 2.—"Fulmen" Arrester.

In operation, the atmospheric discharge finds a free passage to earth, except one small gap of one-twentieth of an inch, which is promptly bridged. Once started across so small a span, the dynamo current quickly establishes a short-circuit, which completely consumes fuse No. 1, and the carbon wedges immediately drop to the free ends of fuse No. 2, bringing it into operative position.

Ten fuses are considered enough to protect one locality during a single thunder-storm, after which the arrester should be examined and any missing fuses be replaced with new ones.

The porcelain covers will be interchangeable, so that replacing fuses will amount to no more than changing covers, reloading the empty covers at leisure.

Since the operation of this arrester depends upon a short-circuit, it is designed only for circuits using a ground return or a ground wire. This arrester is made and sold by Mr. C. S. Van Nuis, 136 Liberty street, this city.

A CARD FROM MR. S. D. BREWER.

We have been requested by Mr. Brewer to publish the following open letter:

It having been brought to my attention within a day or two that printed matter is being circulated wherein my name appears as general manager of the "Hussey Re-Heater and Steam Improvement Company," I would state that I have not been connected with that company for two years.

For your further information I would advise you as follows:

In 1883 Mr. Hussey patented two re-heaters for re-heating exhaust steam. These re-heaters were manufactured and sold by Mr. Donaldson and Mr. Hussey conjointly, afterwards by Mr. Donaldson, and in 1884 by the Donaldson Heater Company, of which I was secretary. Within a few months I, individually, secured the exclusive right to manufacture and sell them.

In 1888, on the strength of certain promises, I organized with others the "Hussey Re-Heater and Steam Plant Improvement Company," of which I was general manager. But after two years with that company, I resigned as its general manager, at the same time withdrawing such interests as I had, and since then I have had no further connection with it.

I intended at the time to open an office for the continuation of my business, but while making the necessary arrangements I concluded to spend a short time in the electrical business, since I knew very little about electricity and realized that it was to play an important part in the steam business. I entered the Edison Company and only recently left it.

How long my name has been used in the manner mentioned I do not know, but I wish, even at this late day, to state that I am not interested, either directly or indirectly, in any business except my own.

Very truly yours,
S. D. Brewer,
Hussey Re-Heater System,
50 Broadway, New York.

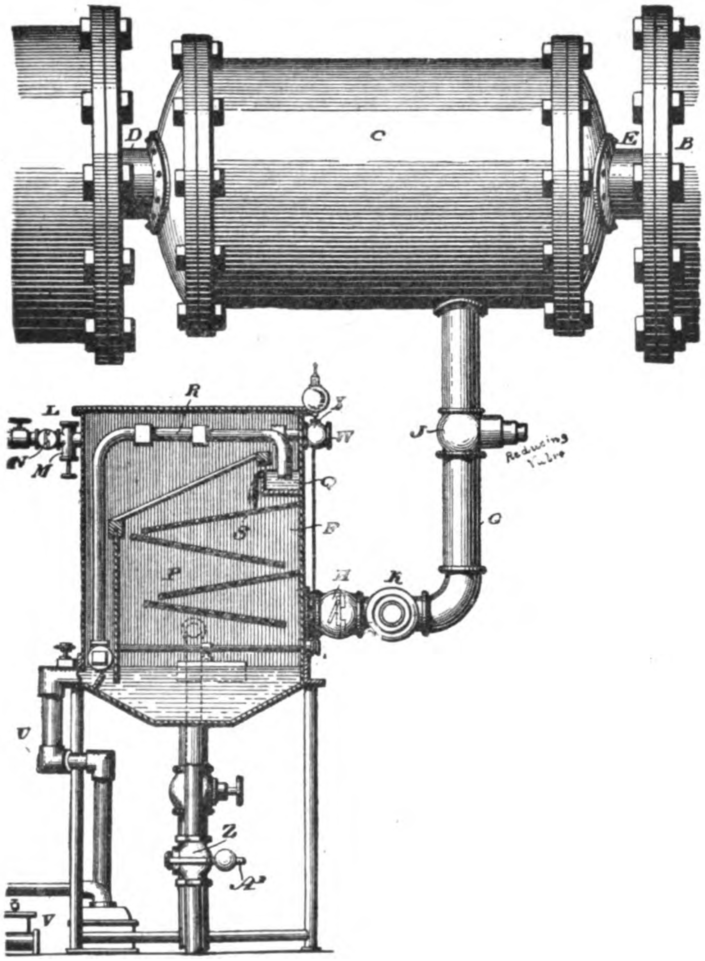
June 18, 1892.

MESSRS. WOODHOUSE & RAWSON UNITED, LIMITED.

The above firm have opened a branch office and show-room at 22 Rue Lafitte, Paris, which will be the chief depot for their French trade, where all communications should be addressed to Mr. E. Kenealy, the manager. Mr. E. H. Cadiot no longer represents the firm in France. Messrs. Woodhouse & Rawson report that they have secured another large contract, to wit, the machinery and plant for softening the water for the St. Helens Corporation Water Works. The total cost of the contract will be $50,000.

WEBSTER'S IMPROVED FEED-WATER HEATER.

It is usual in heating feed-water in connection with a compound engine to pass the exhaust-steam from the last cylinder through a coil-heater to a condenser, where, owing to the vacuum which is maintained therein, the exhaust-steam is withdrawn and reduced in pressure to such an extent that it is not practical to heat the feed-water, which is taken from a hot well at a temperature of about 100° to over 140°, when it is passed into the boiler.



Webster's Improved Feed-Water Heater.

It has been shown, however, that the best economy is attained when the feed-water enters the boiler at the boiling point, or 212° F., and in marine practice live steam under boiler pressure is, in many cases, fed directly into the feed-water heaters to accomplish this object. In order to obtain the same results without losing the work contained in the steam at boiler pressure, Mr. Warren Webster, of Philadelphia, has recently designed the feed-water heater illustrated in the accompanying engraving.

The object accomplished is to take the water from the hot well, or, if there is a coil-heater between the last cylinder and the condenser, to take the water from that at the maximum temperature which can be obtained, which would be, as previously stated, about 140°, and feed it into the water-inlet W; then to heat it to a higher temperature by steam from the steam-receiver after a portion of the energy of the steam has been utilized in one or more steam cylinders from the time it left the steam-boilers under full pressure before it entered the steam-receiver. There is taken from the steam-receiver C just the quantity of steam which is sufficient to heat the feed-water to 210° or 212.° To accomplish this the branch pipe G, is employed with a pressure-reducing valve located therein, from the steam-receiver C to the vacuum-heater, and by this the pressure in the steam-pipe leading from the reducing-valve into the vacuum-heater is cut down to as near steam at 212°, or atmospheric pressure, as possible.

By this device steam of less pressure than that carried in the steam-receiver is utilized, and the maximum amount of water is heated by the minimum amount of steam, the same being reduced by either or both of the valves J and K, as desired. The air in the heater escapes by the outlet pipe L, the check-valve N preventing its return unless the vacuum is too great, when the automatically operating inlet air valve M, which can be weighted to any desired extent, will admit the necessary or required amount.

A discharge-pipe U conveys the feed-water from the heater to a pump V.

THE NOVELTY ELECTRIC CO.'S NEW SWITCH.

Among the many new specialties being introduced by the Novelty Electric Co., of Philadelphia, none is destined to meet a more ready acceptance by the electrical fraternity than their new switch, now about ready for the market,. The full-size illustration here shown, is the size of the 5 and 10 ampere and three-way switches. Other sizes will follow in the near future. The design is very handsome. It has corrugated shell and handle, corresponding in style to the latest designs of electroliers. The shell is furnished in dipped and polished brass, plain and oxidized silver old copper, black or any finish desired to match the fixtures.

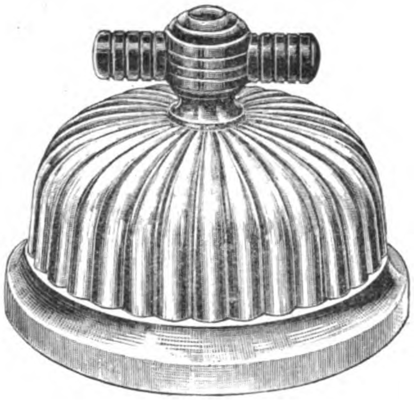


Fig. 1.—The Novelty Electric Co.'s New Switch.

The working parts of the switch are very simple in construction. The flexible contact spring is made of four leaves of phosphor bronze, insuring great flexibility and a long (nearly ⅜ of an inch) close contact, very quick double-break, breaking-in space, preventing the possibility of any metal carrying to the porcelain. The wire is quickly and easily attached, making firm close contact.

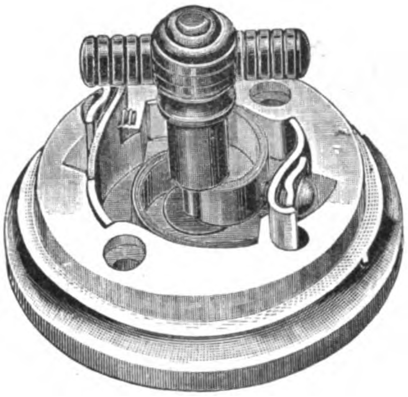


Fig. 2.—The Novelty Electric Co.'s New Switch.

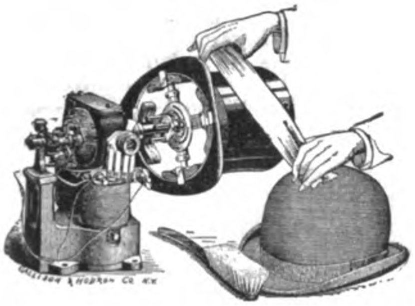
J. ELLIOTT SHAW & CO.

The countless electrical and mechanical specialties manufactured and dealt in by Messrs. J. Elliott Shaw & Co., of 632 Arch street, Philadelphia, are shown and described in their "List B" for June. This is a catalogue of 100 pages, profusely illustrated, and of convenient size. The list includes everything from books to buzzers, dynamos to door openers, galvanometers to gongs; in short, from air compressors to zinc rods, and would be interesting for the very variety, if it were not so for the quality, of its contents.

The Berlin Iron Bridge Co., of East Berlin, Conn., are now building a new machine shop for the Solvay Process Company, at Syracuse, N. Y. The building will be 50 feet wide by 300 feet long and three stories high. The side walls will be of iron and brick (combination construction), with iron floors and iron roof, covered with the Berlin Company's patent anti-condensation roofing.

The W. S. Hill Electric Company, of 54 Devonshire street, Boston, will remove its office to the Works, 133 Oliver street, the latter part of this month.

EVERY MAN HIS OWN HAT IRONER.



THE Crocker-Wheeler Electric Company are ever on the alert to find new fields in which to extend the sale of their motor. Their latest combination is in the form of a hat-polishing machine. Their $\frac{1}{16}$ h. p. or $\frac{1}{8}$ h. p. motor is fitted with a device that holds the hat firmly, so that while the shaft revolves at high speed the hat is turned with it, and the operator holds a polishing band against it, thus getting a much finer and much quicker polish than can be attained by hand.

Large numbers of these have already been used, and the time will come when every man will want to be his own hat ironer instead of heating a hat over the fire and warming himself up brushing it. He will simply turn the button, hold the brush, and the motor will do the rest.

THE RAILWAY EQUIPMENT CO.

AFTER much trying delay, the Railway Equipment Co., successor to the Electric Merchandise Co., Chicago, is ready to welcome its patrons to its elegant quarters in the Pullman Building. The rooms have been in the hands of the decorator and finisher for several weeks, and everything possible has been done to make them beautiful and comfortable. The offices front upon Michigan avenue, and are on the ground floor. To the immediate left of the entrance is what might be called the visitors' parlor—a space enclosed by a neat railing and containing table and chairs for the comfort and convenience of callers. This office fronting on Michigan avenue makes a pleasant waiting-room for visitors.

The general manager's office is also in front and just back of the visitors' parlor, and is well lighted and ventilated by one of the large avenue windows. To the rear of the general manager's office is that of the secretary and treasurer, agreeably accessible to customers. Next in order upon the right, is the book-keeping department with the necessary desks and files. Enclosed by the book-keeping department is a neat space for the use of the stenographers. The purchasing agent occupies the rear of the main office on the left, where he is conveniently near the storerooms and shipping department. A youthful usher at a desk to the right of the doorway is at your service upon entrance. The same side of the office furnishes enclosed desk-room for the salesmen, and also space for a large show board, where are exhibited all the various pieces used in electric railway construction. If one desires to see quantity, rather than to examine the quality of the company's wares, a door at the farther end of the offices admits him to a storeroom where bins and shelves filled with the many devices handled by the house line the walls. Much of the more bulky material is kept in the spacious storerooms in the basement. The rooms are well lighted by electricity throughout, and will make a delightful home for the new company.

Moving into such commodious and pleasant quarters is the natural outcome of the growth of this company's business, and a witness of its popularity with the trade. Three years ago, under another name, but with the same general manager in charge, it started in a unique business—the handling of electric railway supplies exclusively, and since then has done an ever-increasing business. Less than a year ago its quarters were found insufficient and were doubled; again it became necessary to better its facilities. A great many of the electric railways of this country are its regular customers.

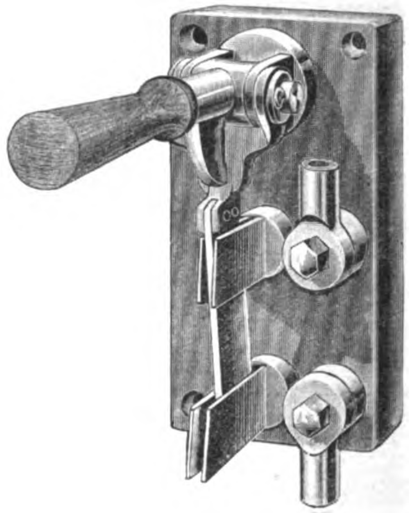
Irrespective of the pushing qualities of the company, its prosperity is undoubtedly largely due to its honest intention to furnish the best possible quality of material to purchasers. That it is imbued with a progressive spirit is evident from the frequent improvements in its devices and the continual additions thereto. All friends of the Railway Equipment Co., and of its general manager, Mr. W. R. Mason, will extend congratulations upon the appearance of its new home and its bright prospects.

A GOOD WAY TO SPEND YOUR HOLIDAYS.

THE question of the hour is, Where are you going to spend your vacation? "Don't know." Well, why not select one of the delightful spots along the Hudson, or the St. Lawrence, or among the far-famed Thousand Islands, where there is really no limit to the pleasure to be obtained, and where boating, fishing and hunting abound? These points are easily accessible, owing to the well-arranged summer plans of the New York Central and Hudson River Railroad. There is no gainsaying the fact that some of the loveliest resorts on the continent lie on or near to this great railroad system. Their complete guides, "Tourist" and other, are most desirable literature to secure just at the present time. An elaborate tourist's catalogue is being prepared, and will be ready for distribution in a very few days.

C. & C. SNAP SWITCHES.

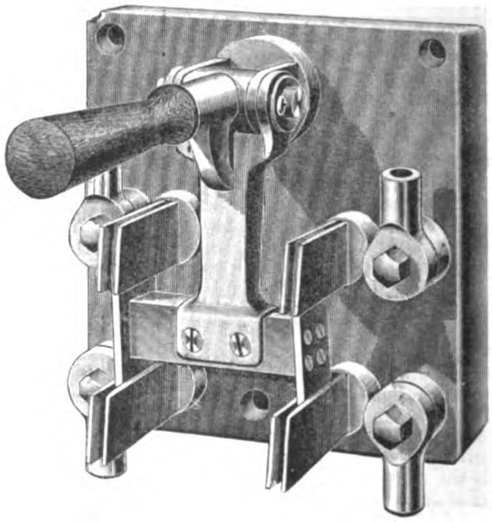
THE accompanying cuts represent the single-pole and double-pole snap switches recently placed upon the market by the C. & C. Electric Motor Co. The plain switches designed by this company have the same general appearance, the only important difference being the omission of the snap spring in the plain switch, while the handle lever and knife lever are replaced by a single casting.



C. & C. SINGLE POLE SNAP SWITCH.

Almost all specifications for electric lighting plants now call for marble or slate switchboards instead of the wood board, which was formerly considered satisfactory. The switches that were designed for the wood boards have been made to do service on the marble, but owing to their construction they do not make a handsome appearance. The switches here illustrated were designed specially for this class of work, and have been provided with ample contact surface and quick break and the metal parts are so solidly constructed as to obviate any possible danger of breaking.

The connections are made from the back of the switchboard to these switches, but the contact binding posts are made extra long so that when wanted the switches may be supplied to be fitted to a switchboard of any thickness.



C. & C. DOUBLE POLE SNAP SWITCH.

On switches provided with fuse blocks and mounted on slate bases, the distance between the fuse terminals is made ample enough to render the fuses perfectly reliable and to prevent any danger of arcing across. This feature is specially desirable when the switches are used on 500 volt circuits.

"ELECTRIC BREEZES."

MR. C. T. EVANS, of 102 Fifth avenue, Pittsburgh, Pa., has issued a very clever little bulletin under the above heading, in which the praises are sung of fan motors. He remarks that electric cold is as pleasant a theme for summer as electric heat is for winter, and that a breeze will promote energy and patience as much as a dose of quinine when one is played out or lassitudinous.

ELECTRICAL DIVIDENDS.

THE WESTERN UNION TELEGRAPH Co. has declared a regular quarterly dividend of 1¼ per cent. The surplus is now reported as being $2,098,798 for the year. The American Bell Telephone Co. has also just declared its quarterly dividend of $3 regular and $3 extra dividend, payable the middle of July. Formerly the extra dividends have been $6.

QUICK WORK BY A BULK ELECTRIC CONTRACTOR.

THE advantages which a purchaser may derive by dealing with a bulk contractor are clearly illustrated by a remarkable installation recently made at White Plains, N. Y. A very handsome new church was presented to the parish by Mrs. M. C. Reynal, and the architect, Mr. T. H. Poole, of New York City, contracted with one of the large electrical manufacturing companies to put in wiring and fixtures for electric lights, and made arrangements with the local lighting company to install a special dynamo and supply current.

It was intended to use the lighting plant at the consecration exercises, but as that day drew near it was evident that neither company would be ready. The day before the exercises the architect concluded that he must have electric lights if it were at all possible. Having had satisfactory experience with a well-known bulk electric contractor, of New York City, the architect called upon the concern at 4:30 one afternoon and asked if it would be possible to install the plant and have it running in time for the exercises, which would come of at 10:30 the next morning.

It was necessary to secure, deliver at White Plains, and install the dynamo, complete the wiring of the church, run the line to the central station plant, alter the speed of the engine, supply belting, foundation, etc.

The contract was promptly accepted by H. Ward Leonard & Co., whom Mr. Poole applied to at 4:30 in the afternoon, and at 10:15 the next morning the entire plant was operating perfectly. This is certainly a first-class argument for this method of dealing with a bulk contractor, who shoulders the whole responsibility, and whose reputation and success depend upon the promptest execution of a contract.

THE CONOVER INDEPENDENT CONDENSER.

THE accompanying illustrations, Figs. 1, 2 and 3, show the Conover independent steam engine condenser, made by the Conover Manufacturing Co., of 95 Liberty street, this city.

In Fig. 1 the condenser is seen at the right, the air pump at the left, and the engine in the middle. The air pump is vertical, and single acting, and the current of out-flowing water, mixed with the air as it comes from the condenser, is always upward.

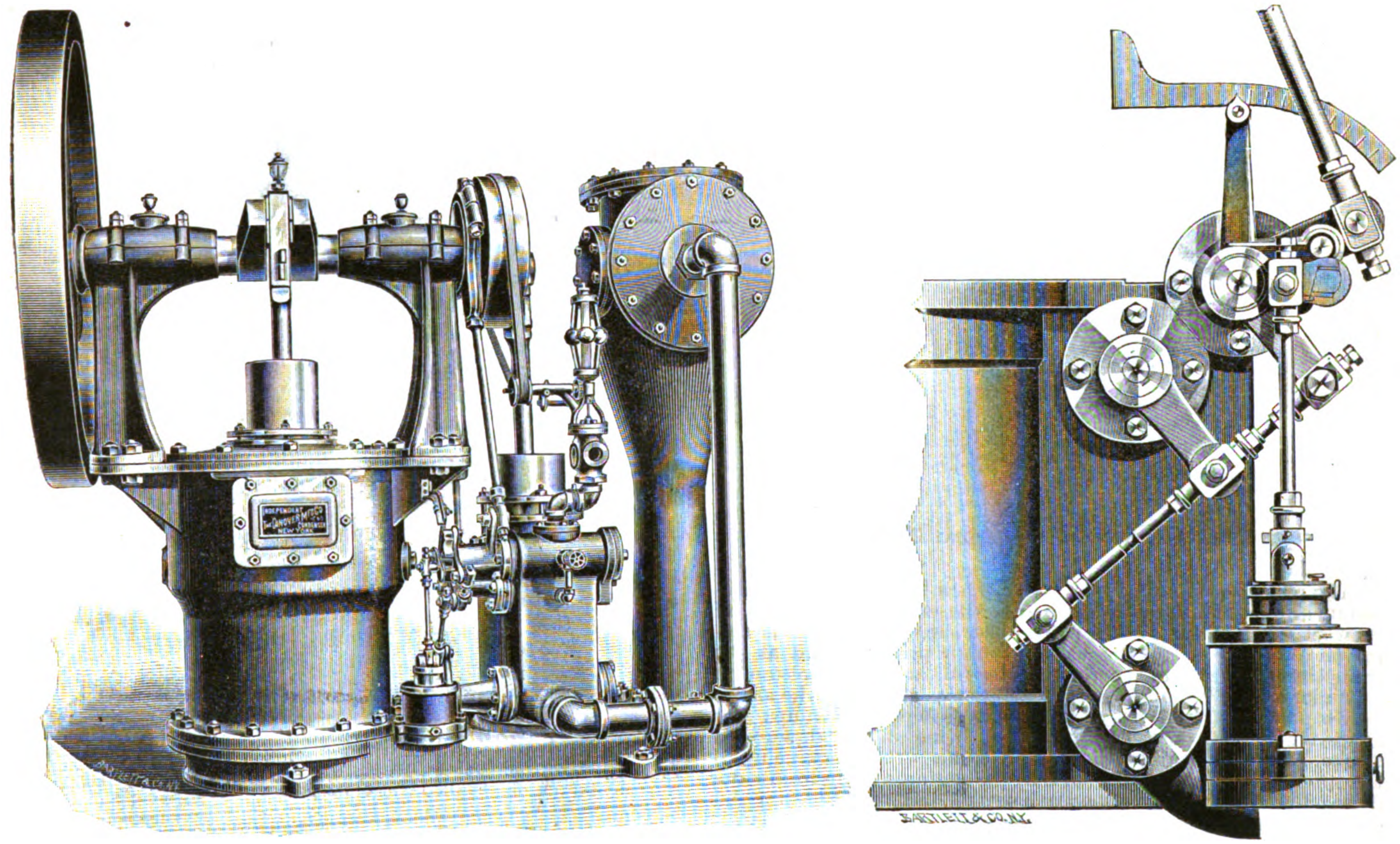
The air pump is of the trunk pattern, and being vertical and having outlets above the valves and stuffing boxes, these necessary parts are automatically sealed with water. The valves are of the best rubber and hold their seats by gravity alone.

It is claimed that this style of air pump will accomplish equal results with the horizontal, double-acting type, and with considerably less piston displacement. As it is single-acting and does all its work on the upward stroke and none at all on the downward stroke, the engine on this condenser is made to do the work on its downward stroke, called for to operate the pump when making the upward stroke.

It will be seen that when the engine is making its downward stroke it has full boiler pressure on its upward side, and the vacuum on the low pressure, or bottom, side of piston, acts on the full area of the diameter of the cylinder and in connection with the steam pressure on the top is sufficient to cause the pump to make its upward stroke.

The condenser is also claimed to run without noise. There is no foot valve at the bottom of the air pump, as the condenser at the right acts as a water column to give the proper head, and force the overflow water through the valves in the piston. On the return stroke, this water is easily forced back slightly by the condenser, avoiding all shock. Advantage is also taken of the velocity imparted to the injection water due to condensation. The pumps are made very heavy and substantial, with extra large crank pins and bearing surfaces, and are intended for continuous night and day use. The air pump is brass lined, the plunger is a solid brass casting, and the diaphragm, stuffing boxes, glands, studs, nuts, etc., are all made of brass. Over a ton of brass is used in a condenser of 1,500 h. p. capacity. In the smaller sizes the amount of brass is about one-sixth of the total weight of the machine.

The Conover special compound condensing engine is shown in section in Fig. 2. As will be readily understood, an ordinary engine coupled directly to an air pump would be compelled to store a large amount of energy in the fly-wheel, as it would be too powerful on one stroke and not sufficiently so on the other. The special engine is designed, therefore, to obviate this difficulty. It



FIGS. 1 AND 3.—CONOVER INDEPENDENT CONDENSER, ENGINE AND VALVE GEAR.

is of the trunk pattern, and the small space around the trunk on the top side of the piston forms the high pressure cylinder. Steam is admitted to the high pressure side at boiler pressure, is cut off and expanded and exhausts into the receiver, where it is admitted to the bottom side of the piston, and again cut off and expanded, and then exhausted to the condenser.

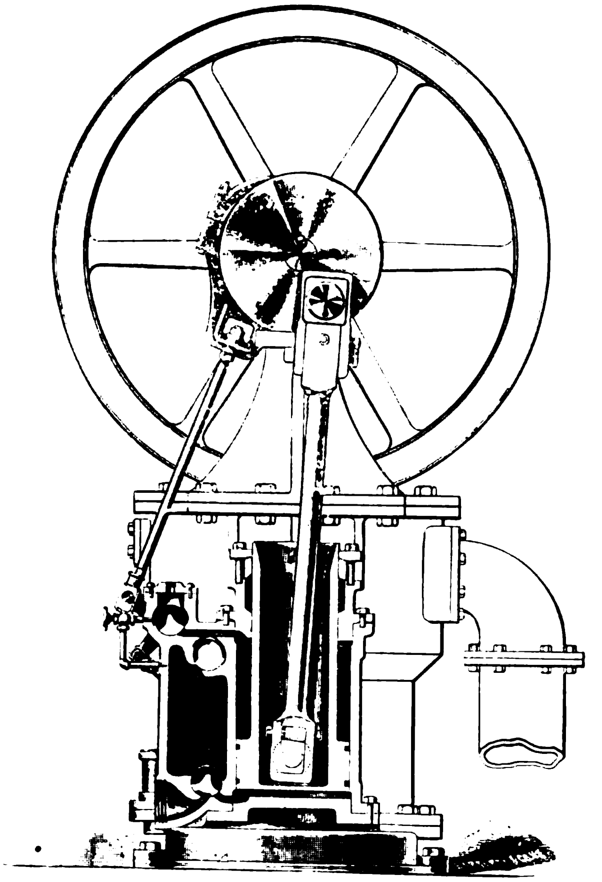


FIG. 2.—CONOVER CONDENSING ENGINE.

The piston makes the down stroke when the air pump makes the up stroke, and it will be seen that the engine does nearly all its work when making the downward stroke. The steam is acting on the upper side of the piston at high pressure, and at the same time the vacuum is acting on the full area of the piston on its under side. When the engine makes the up stroke, the steam at low pressure from the receiver acts to push the piston up; and as the air pump is doing no work then, being on its downward stroke, the engine is only called upon to keep the machine up to the speed. It will thus be seen that the engine is made to suit the demand of the large power on one stroke, and very little on the other, thus adapting itself very perfectly to the requirements.

Fig. 3 shows the arrangement of the engine valve gear. The upper end of the cylinder, on the high pressure side, has two Corliss valves. The top valve admits steam, and being fitted with releasing gear, also cuts off the steam. The point of cut-off is regulated by the hand adjustment shown. The throttle governor regulates the initial steam pressure that is required by the point of cut-off. The lower valve at the upper end of the cylinder is an exhaust valve, and has a fixed travel. The bottom valve is also a Corliss valve, and admits steam from the receiver to the bottom side of the piston. Its point of cut-off is fixed by the eccentric, and takes place at five-eighths of stroke. This valve also exhausts the steam to the condenser.

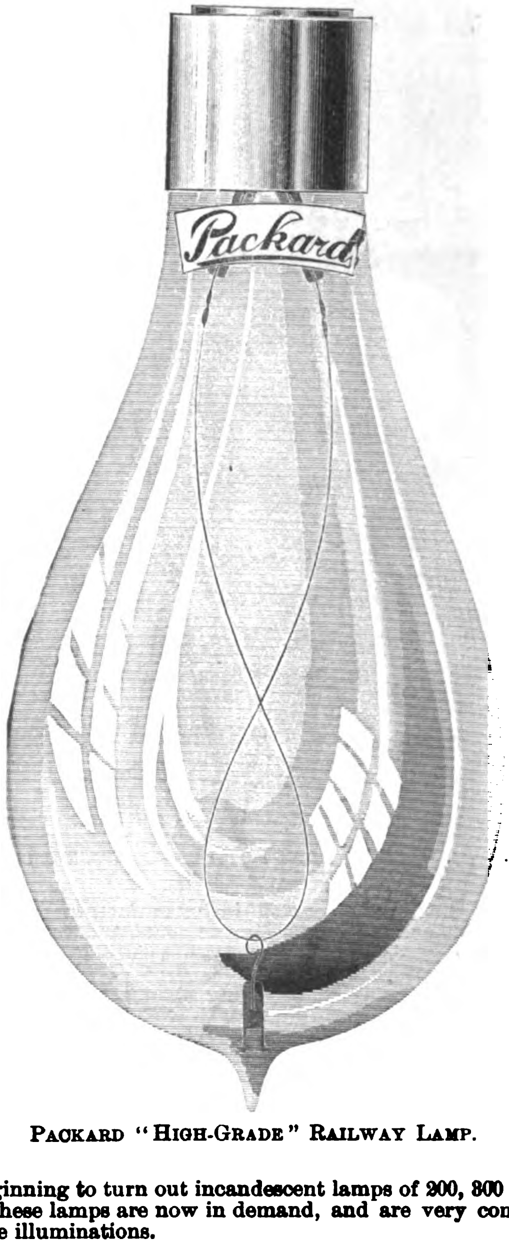
The releasing gear is a complete Corliss, and the latch plate has sixteen wearing edges. The valves are all adjustable, by means of the connecting rods fitted with right and left threads, and are also arranged to lift off their seats in case of water getting into the cylinder. The piston is made extra deep, and never exposes the upper end of the cylinder to the vacuum temperature of the lower end.

The double condenser, made by this company, has all the special features of the single machine, but the two single-acting air pumps are connected opposite one another and give a continuous and easy motion for very large powers. A special arrangement provides for connecting the central wheel to either pump, making it possible to run either side or the entire machine at pleasure. The spray in the condenser, at the end of the injection-pipe, is arranged to catch all floating matter that passes the foot valve screen. It is claimed that with this arrangement it is much easier to remove any foreign matter that collects in the spray than to allow it to go through the air pump and collect in the valves. These condensers are furnished in either belt or steam driven form.

THE PACKARD "HIGH-GRADE" LAMP.

WE illustrate through the courtesy of Mr. Chas. E. Chapin, general Eastern agent, 186 Liberty street, this city, the Packard lamps as now manufactured. The tied or supported filament lamp is used on railroads or where violent vibrations are common. It has a platinum wire cemented to the bulb and bent around the filament in the usual way.

The Packard lamps came on the market about a year and a half ago stamped "High-Grade." The general public queried "Are they?" Gradually the lamps became known, and they now merit a place among the best from the record made. They give a pure white light and are of remarkably long life. Few go things are produced by accident, and experience, appreciatio fine details, close inspection, and a thorough knowledge of business, are requisite in the manufacture of incandescent la Messrs. J. W. and W. D. Packard fill these requirements. Their company (the New York and Ohio) at Warren, Ohio are



PACKARD "HIGH-GRADE" RAILWAY LAMP.

also beginning to turn out incandescent lamps of 200, 300 and 500 c. p. These lamps are now in demand, and are very convenient for large illuminations.

☞ ***Departmental items of Electric Light, Electric Railways, Electric Power, Telegraph, Telephone, New Hotels, New Buildings, Apparatus Wanted, Miscellaneous, etc., will be found in the advertising pages.***

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